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DIVISION OF ENTOMOLOGY—BULLETIN No. 43.

L. O. HOWARD, Entomologist.

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A BRIEF ACCOUNT

OF THE

PRINCIPAL INSECT ENEMIES OF THE SUGAR BEET.

BY

F. H. CHITTENDEN,

Entomologist in Charge of Breeding Experiments.

22

WASHINGTON:

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1903.

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LETTER OF TRANSMITTAL.

United States Department of Agriculture,
Division of Entomology,
Washington, D. C., November 3, 1903.

Sir: I have the honor to transmit herewith for publication A Brief Account of the Principal Insect Enemies of the Sugar Beet, prepared by Mr. F. H. Chittenden, of this office. This paper has already appeared as a portion of Report No. 74 of the U. S. Department of Agriculture entitled "Progress of the Beet-Sugar Industry in the United States in 1902," for which it was specially prepared by your instructions. Owing to the subordinate position held by this article, the consideration of the subject was limited to the more prominent insect pests affecting sugar beet, and it was therefore impossible to enter into detail regarding these or other less injurious insects which are known to affect this important crop plant. Many of the species, especially those of greatest economic importance, have received more extended notice in other publications of this office, notably in Bulletins Nos. 19, 23, 29, 33, and 40, of the same series, and there are many others known to affect sugar beet which are not even mentioned, chiefly because we are not sufficiently conversant with their economic status.

I recommend the publication of this paper as Bulletin No. 43, of this Division.

Respectfully,

L. O. Howard, *Entomologist.*

Hon. James Wilson,
Secretary of Agriculture.

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A BRIEF ACCOUNT OF THE PRINCIPAL INSECT ENEMIES OF THE SUGAR BEET.

INTRODUCTORY.

The Reports on the Progress of the Beet-Sugar Industry, by Mr. Charles F. Saylor, special agent of the Department, show that the world's production of sugar in 1902 amounted to nearly 10,000,000 tons, of which nearly three-fifths was manufactured from sugar beets. The increase in the production of sugar from beets as compared with the production from cane has for many years been rapid and continuous. The first attempt to manufacture beet sugar in the United States was made in 1830. After numerous failures a successful factory was established in California about twenty-five years ago. In 1891 only three beet-sugar factories were in operation in the United States; but by 1902 the number had increased to 42, with many more in prospect. The manufacture of enough sugar to supply our home demand would require the operation of about 400 factories, or as many as there are in Germany, the principal sugar-beet growing country of the world. This in turn would require the cultivation of a very large acreage in sugar beets. More than $50,000,000 is reported to be invested in the beet-sugar industry in this country, and there is promise that the industry may, before a great many years, develop to the extent above indicated. Hence, any information which may be of use to sugar-beet growers is of immediate interest and practical value.

Although the beet-sugar industry is still in its infancy in America, already many insects—150 species in round numbers[a]—have been found to use beets as food, and, while comparatively few occasion losses of consequence, with the coming of years and the increase of cultivation of the sugar beet, other insects will acquire the habit of feeding upon it, and more extensive injuries may be expected each successive season.

If we leave out such forms of insects as blister beetles, army worms and cutworms, flea-beetles, leaf-beetles, and some few others, we may say that beets at the present time suffer comparatively little damage through insect ravages. The recent extension, however, of sugar-beet culture in this country has been the means of bringing to notice, through the publications of the Department of Agriculture and several of the State experiment stations,[b] a large number of insects not previously identified with attack on that plant.

A very considerable proportion of the insect enemies of sugar beet which are practically identical with those which affect table beet and

[a] Forbes & Hart, Bul. 60, Univ. Ill. Agl. Expt. Sta., 1900, pp. 397–532.

[b] See Bruner, Bul. 23 [old ser.], Div. Ent., U. S. Dept. Agriculture, 1891, pp. 11–18; Osborn & Gossard, Bul. 15, Iowa Agl. Expt. Sta., 1891, pp. 265–272; also numerous shorter articles.

spinach, subsist normally on wild plants of the same botanical order—the Chenopodiaceæ, or goosefoot family, which includes our common lambsquarters (*Chenopodium album*), spinach, and some related plants that are cultivated for ornament and as forage crops. Of the latter are several forms of saltbush (Atriplex). Many beet depredators also live on plants belonging to an allied family—the Amaranths—which contains many common weeds, including pigweed, as well as a few ornamental forms.

One of the earliest instances of injury to the beet reported in America is that furnished by our first economic entomologist, Harris,[a] in 1841. In quite recent years, however, several species have been so prominent as pests in fields of sugar beet that they have received names indicative of their beet-feeding habit, while a few take their common names from spinach. Among these are the beet army worm,[b] the beet webworm,[c] the beet or spinach leaf-miner,[d] spinach flea-beetle,[e] beet carrion beetle,[f] beet aphis,[g] European beet tortoise beetle,[h] and two species of leaf-beetles.[i] Of the various insects known to live on this plant, not more than about one-third, or 40 or 50 species, can be classed as noticeably destructive to it.

It is difficult to decide at this time, owing to the lack of study given the subject over the entire country where beets are raised, which forms of insects are of the highest importance. The different insects which have been mentioned specifically are more attached to beet and spinach than to other plants, and the greatest losses, if we take the entire country into consideration, are probably due to the ravages of flea-beetles, but they, as well as cutworms and similar groups, are so periodical or, more properly speaking, irregular in their depredations that an exact estimate of their economic status can not be made. Different species of leaf-beetles and caterpillars other than cutworms do more or less injury, and several blister beetles devour the foliage of sugar and table beets freely; most forms of the last, however, usually make their appearance so late in the season that, although defoliation may be excessive, comparatively little damage is accomplished. The same is true of some species of grasshoppers.

Beets until recently were comparatively free from subterranean insect enemies, but there are two forms of common farm pests, white grubs and wireworms, that affect underground portions of the plants and occasionally injure them; in addition to these, some kinds of root-lice and mealy-bugs injure the roots by suction, rendering them small

[a] The species mentioned is the zebra caterpillar (*Mamestra picta*). Rept. Ins. Mass. Inj. to Veg., p. 328.

[b] *Caradrina exigua.*

[c] *Loxostege sticticalis.*

[d] *Pegomya vicina.*

[e] *Disonycha xanthomelæna.*

[f] *Silpha opaca.*

[g] *Pemphigus betæ.*

[h] *Cassida nebulosa.*

[i] *Monoxia puncticollis* and *M. consputa.*

and soft or spongy when they do not kill them outright. Some other sucking insects—plant-lice, plant-bugs, leaf-hoppers, and the like—occasionally injure the plants by absorbing their vital juices, but with some notable exceptions they are comparatively unimportant as beet pests.

Many of the most destructive or best known sugar-beet pests have received more extended notice in recent publications of the Division of Entomology, notably in Bulletins 19, 23, 29, 33, and 40, new series (from which the present article has been largely collated), in addition to other publications which have been cited in the introductory paragraph and others which will be mentioned in connection with the different species as they are considered.

In indicating methods of control to be observed for insects which are not special enemies of the sugar beet, it has been found necessary, owing to our somewhat imperfect acquaintance with all of the conditions which surround attack, to treat the subject in a general manner. The remedies for different forms and classes of insects are therefore considered as they occur upon the farm. Where deemed advisable, however, an effort has been made to limit remedial directions to the occurrence of many of these insects in fields of sugar beet. It may therefore be stated that as a general rule remedies prescribed for insects as these occur on their favorite food plants also serve for their destruction on other crops. Exception is made of insects such as the southern corn root-worm, which is a prime enemy of corn, though the beetles are usually to be found in beet fields, since the elaborate treatment which is often necessary in combating this pest on corn, need not be employed on beets and other crops where its injuries are comparatively insignificant.

LEAF-BEETLES AND FLEA-BEETLES.

Several leaf-feeding beetles of the family Chrysomelidæ, known as leaf-beetles and flea-beetles, are quite conspicuous as enemies of the sugar beet. Three of the leaf-beetles are apparently peculiar to beets among cultivated plants, injuring them both in the adult and the larval stage, while numerous flea-beetles, although as a rule general feeders, are even more destructive by attacking the plants early in the season, when they are least able to withstand injury.

THE LARGER SUGAR-BEET LEAF-BEETLE.

(*Monoxia puncticollis* Say.)

With the cultivation of the sugar beet in the West there has come to prey upon it a moderate-sized leaf-beetle, known in parts of New Mexico as the "French bug."[a] Its presence in beet fields was first

[a] See the author's article, Bul. 18, Div. Ent., U. S. Dept. Agr., p. 95.

noticed simultaneously in that Territory and in Colorado in 1898, when it did serious injury to crops. The beetles are gregarious, sometimes occurring "in swarms like blister beetles." Their brownish gray eggs are deposited in irregular masses, usually on the under sides of leaves. They hatch in about six days, and their larvæ or young commence feeding at once, continuing for nine or ten days, when they dig their way into the ground, a few days later coming forth as beetles. Although the beetles do much injury, the principal damage is sometimes accomplished by the larvæ, hundreds being found on a single small plant, which is either consumed or so injured that it shrivels and dies. In 1902 this insect did considerable injury to sugar beet in Colorado.[a] It feeds on several wild plants, blites (*Dondia americana* and *D.*

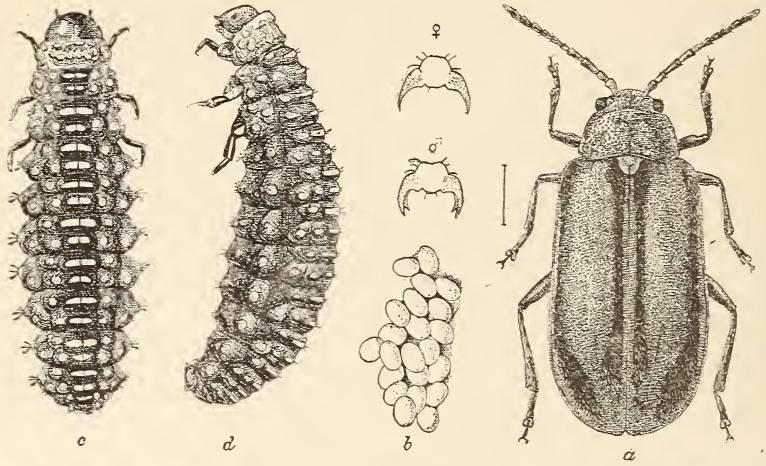

FIG. 1.—*Monoxia puncticollis: a*, female beetle; *b*, eggs; *c*, larva, dorsal view; *d*, larva, lateral view; ♂, claw of male; ♀, claw of female—all much enlarged, male and female claws more enlarged (author's illustration, Division of Entomology).

depressa), Russian thistle (*Salsola tragus*), and saltbush (*Atriplex argentea*), is double-brooded according to Prof. C. P. Gillette,[b] and occurs throughout the summer.

This species is related to the imported elm leaf-beetle, but is larger and differently marked. The beetle is quite variable, both as regards the markings and size, the length being from one-fourth to one-third of an inch. It is of oblong form, narrow in front. The color varies from pale yellow to entirely black, while the elytra or wing-covers are more or less distinctly striped. The surface of the thorax is coarsely and irregularly punctate. Five varieties or races are recognized. The beet-feeding form is illustrated in figure 1, *a*. The larva, shown in the same illustration, *c*, *d*, measures when full grown about one-third

[a] Bul. 40, Div. Ent., pp. 111–113.

[b] Twenty-fourth Rept. Colo. Agric. Expt. Sta., 1902, pp. 108–111.

of an inch in length. The general color is nearly uniform dark olive brown, the conspicuous piliferous tubercles being pale yellow, and the head and portions of the legs black. The eggs (*b*) are dull brownish gray, and the surface, as seen through a lens, is covered with septagonal and hexagonal areas.

A common variety of this species, not thus far noticed, however, in beet fields, is illustrated in figure 2. It has been observed in Nebraska, Texas, and Florida.

Remedies.—This and the Western beet leaf-beetle are apt to become important enemies of sugar-beet culture unless remedial measures are instituted. The general methods for the control of leaf and flea-beetles (see page 169) are all applicable, but a few remarks should be added in regard to particular remedies for these two species. Paris green, London purple, and paragrene have all been employed against the larger species with apparently good results when applied dry, mixed with flour, in the same manner as for the Colorado potato beetle. Against the Western species a spray of Paris green with whale-oil soap has been used with success, the beneficial effect lasting about six weeks, the beet leaves not being injured. There is no especial advantage in the addition of the soap, and the arsenical used alone or with Bordeaux mixture would have answered still better.

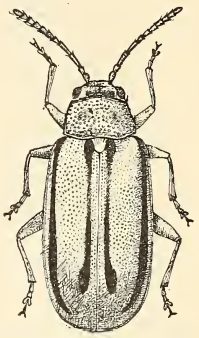

FIG. 2.—*Monoxia punctticollis*, variety—5 times natural size (author's illustration, Division of Entomology).

Two interesting facts brought out in the course of Professor Gillette's observations on the larger insect in Colorado are of value as indicating methods of control. It was observed that the beetles accumulated quite largely upon "mother" beets early in the spring, which suggests that if a few beets be left in the ground over winter they will serve as trap crops for the protection of the younger plants in spring. It was noticed also that the insect appeared to confine its injuries to plants growing in alkali ground or in close proximity to such soil. Hence such ground is to be avoided for the cultivation of beets.

THE WESTERN BEET LEAF-BEETLE.

(*Monoxia consputa* Lec.)

Garden as well as sugar beets are injured by this species, particularly along the Pacific coast. It first attracted attention in the years 1890 and 1891 in Oregon, where it did considerable injury (F. L. Washburn, Bul. 14, Oregon Agl. Expt. Sta., p. 11.). It eats holes through the leaves, in some instances leaving only a network of the original leaf, and this seriously interferes with the growth of young plants, which are sometimes killed.

This beetle (fig. 3) is smaller than the preceding, measuring only about one-sixth inch in length; is pale yellowish brown in color and moderately variable, some individuals being plain, while others are marked with black spots arranged in nearly regular series.

It is a Western species, but ranges as far eastward as the Dakotas, and is found in Montana, Utah, Colorado, Kansas, Arizona, and the Pacific States. There is no record of injury by the larva, but there is little doubt that it also affects this plant, and in much the same manner as does that of the larger sugar-beet leaf-beetle. Injury has been noticed in Oregon toward the end of August, continuing for six or eight weeks.

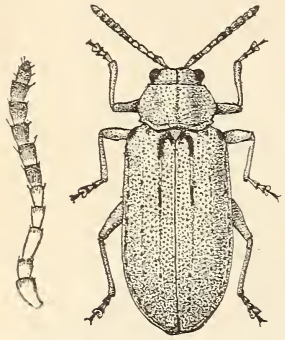

FIG. 3.—*Monoxia consputa:* beetle, 8 times natural size; antenna at left highly magnified (original, Division of Entomology).

THE SOUTHERN CORN ROOT-WORM.

(*Diabrotica 12-punctata* Ol.)

As this species is present everywhere in beet fields the year round, it is familiar to most beet growers. The adult is best known in the North as the twelve-spotted cucumber beetle, from its partiality for flowers of cucumber and related plants. In the South the young or larva is called the "bud worm" from its pernicious habit of burrowing into and eating young cornstalks soon after the germinating period.

The beetle (fig. 4) measures nearly one-fourth of an inch in length, is yellowish-green in color, and the elytra or wing-covers are marked with twelve black spots.

This beetle is practically omnivorous, feeding upon almost any form of vegetation upon which it happens to alight. Although very fond of flowers, it is liable to attack any portion of a plant, finding food on the foliage and other portions of most garden and many field crops, the flowers and leaves of fruit trees, and the bloom of many ornamental plants. The larva develops on the roots of grasses, as well as corn, and even on beans and some other plants. The beetles have been

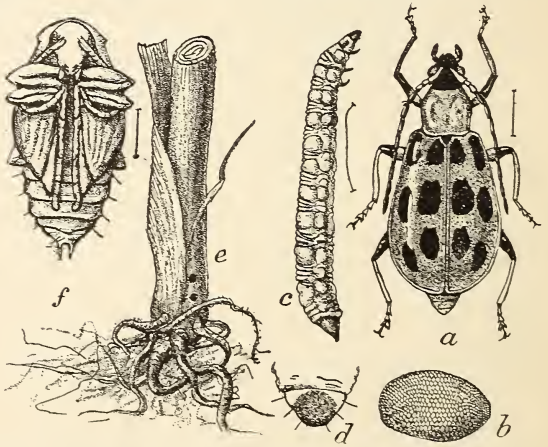

FIG. 4.—*Diabrotica 12-punctata: a*, beetle; *b*, egg; *c*, larva; *d*, anal segment of larva; *e*, work of larva at base of cornstalk; *f*, pupa—all much enlarged except *e*, which is reduced (reengraved after Riley, except *f* [original], Division of Entomology).

accused of being carriers of various plant diseases, and probably with justice, since they have a habit of flying frequently from one plant to another, feeding on each in turn. In the leaves of beets and other vegetables they make many small, irregular holes, and are capable of doing considerable damage when occurring abundantly on young plants. It is not known how many generations are produced during the year, but as the beetle is one of our earliest as well as latest species, it seems probable that two or perhaps three generations may be produced annually, at least in the more southern States.

Remedies.—Ordinary leaf-beetle remedies are applicable to this species in its occurrence on beets. On cucumber and other cucurbits, however, it is more troublesome, and must be treated in about the same manner as the striped cucumber beetle (see Circular No. 31, Div. Ent.). On corn it is still more difficult to control the root-worms, and this subject will be reserved for discussion elsewhere. The results of experiments with remedies are given in an article on this species by A. L. Quaintance (Bul. 26, n. s., Div. Ent., pp.39–40).

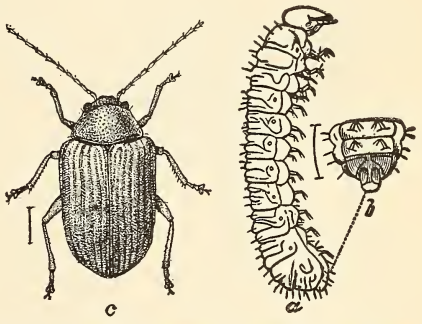

FIG. 5.—*Colaspis brunnea: a*, larva or root-worm; *b*, anal segment of larva from above; *c*, beetle—all enlarged (*a*, *b*, after Riley; *c*, original, Division of Entomology).

THE COLASPIS ROOT-WORM.

(*Colaspis brunnea* Fab.)

This species is best known as a depredator upon grape and strawberry, on which the larvæ also subsist, whence two of its vernacular names of grapevine colaspis and strawberry root-worm, but it has frequently been noticed on sugar beet in Nebraska and Illinois. It is also often found attacking the foliage of beans.

The beetle is common and well known. It is exceedingly variable, but typical specimens are yellowish or pale brown, dull or moderately shining, the elytra and legs are a little paler than the other portions. The form is oval, slightly oblong, and moderately convex, the general appearance being about as represented at figure 5, *c*. The larva[a] is a white cylindrical grub, about an eighth of an inch long, with a yellowish-brown head. The pupa is also white and has simple, incurved anal hooks.

This beetle has been recorded as doing more or less injury to several plants other than those mentioned, including potato, buckwheat, corn, clover, beans, cowpea, muskmelon, cotton, and some wild plants, including tick trefoil and New Jersey tea, and the leaves or blossoms of apple, pear, and willow. The larva has also been observed

[a] For particulars the reader is referred to 22d Rept. State Ent. Ill., 1903, pp. 145–149; also Bul. 9, n. s., Div. Ent., p. 21.

feeding on the roots of timothy and other grasses, and Indian corn, in addition to clover, strawberry, and grape, which would lead to the belief that the species might have been originally a grass-feeding one.

There is little doubt that the insect is single-brooded, and it has been surmised that it hibernates as a partly grown larva. The beetles which are to be found from June to September probably also hibernate.

THE BEET TORTOISE BEETLE.

(*Cassida nebulosa* Linn.)

An illustration of this species (fig. 6) and a short notice of it is presented, for the reason that it is one of the few insects which derive their common names from the beet, and because it is destructive to sugar beet in Europe. There is, moreover, some likelihood of its becoming a pest in our own country if it should ever be able to obtain a permanent foothold here. It is reported as having been observed in California in 1894, but as we have heard little of the insect since that time some doubt exists as to its actual establishment in America. It ranges through Europe and in Asia from Persia to Siberia, and it may be that it is destined to become cosmopolitan. Therefore beet growers should be warned against it. In Europe this beetle feeds on lambsquarters, Atriplex, and related plants, but when these plants become exhausted it devastates large areas of sugar beets. There are said to be two generations of the beetles produced annually, one appearing in August, the other in the autumn. The beetle is about one-fourth of an inch long and yellowish gray or pale green in color.

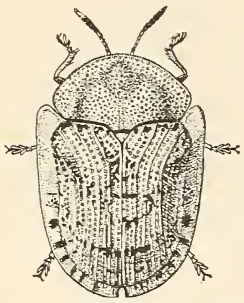

FIG. 6.—*Cassida nebulosa:* beetle, about 4 times natural size (original, Division of Entomology).

Remedies.—The same remedies advised against other leaf-beetles would apply to the present species.

THE SPINACH FLEA-BEETLE.

(*Disonycha xanthomelæna* Dalm.)

Flea-beetles are among the most important enemies of the sugar beet, and of growing importance, as recent reports bear testimony. No less than a score of species have been observed to attack beets. Among the most destructive of these are the spinach flea-beetle, the pale-striped flea-beetle, and the black and red-headed flea-beetles, well-known forms in the East; but in some portions of the West and elsewhere others do more damage. They are most troublesome on very young plants.

Reports of injuries by the spinach flea-beetle to cultivated plants

are rapidly increasing, although it continues to live by preference on weeds and wild plants. The crops most injured are beets, spinach, and saltbush; and natural food plants are chickweed and lambsquarters. The leaves of these plants are riddled with holes, chiefly the work of the larvæ, but also of the beetles, and gardeners complain that spinach may be so badly worm-eaten that it is impossible to offer it for sale. Considerable injury to beets was observed by the writer in 1900, and during 1902 and 1903 the insect has been the most conspicuous species on sugar beet in and near the District of Columbia.

The larvæ, as well as beetles, drop quickly upon being disturbed, and as the former are inconspicuous in appearance, and the latter feign death, the miscreants are apt to elude recognition, the early injury produced being frequently ascribed to cutworms and the later damage to other insects. Frequently from 15 to 20 larvæ live on a single leaf. They feed mostly on the under surface.

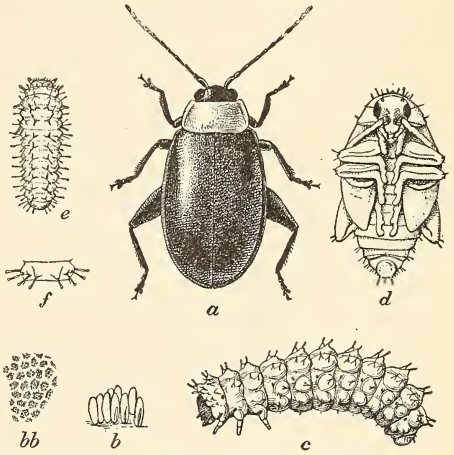

FIG. 7.—*Disonycha xanthomelæna: a*, beetle; *b*, egg mass, showing mode of escape of larva at right; *bb*, sculpture of egg; *c*, full-grown larva; *d*, pupa; *e*, newly hatched larva; *f*, abdominal segment of same—*a*, *c*, *d*, five times natural size; *b*, *e*, more enlarged; *bb*, *f*, still more enlarged (author's illustration, Division of Entomology).

The beetle (fig. 7, *a*) is shining black, sometimes with a greenish or bluish luster. The prothorax and abdomen are red or reddish yellow, and the legs and antennæ pale yellowish. It measures less than one-fourth of an inch. The buff or orange eggs (*b*, *bb*) are deposited in masses. The mature larva (*c*) as it occurs on sugar beet is dull leaden gray, with darker head and still darker brown mouth parts, but on red and purple beets it takes on the color of the plant attacked. This is a native species and of exceptionally wide distribution, its habitat extending from New England to Montana, and from British America to Florida and Texas. It is one of our earliest spring visitors, appearing in the first warm days of March in the Atlantic States, and continuing abroad some years through November. Two generations occur in the District of Columbia, the first usually produced on chickweed, and later ones on beets, spinach, and other plants. It is a prolific insect, as many as 180 eggs having been observed to be deposited by a single female.[a]

[a] A more complete account of this flea-beetle is given in Bul. 19, n. s., pp. 80–85.

THE PALE-STRIPED FLEA-BEETLE.

(*Systena blanda* Mels.)

This species, a beet feeder of long standing, has in recent years come to the front as an important enemy to sugar beets, and table beets are also affected. In 1899 and 1900 much injury was done to sugar-beet fields in Michigan, some having been practically destroyed while the plants were quite young. During 1900 much injury was done in Colorado, the beetles appearing in swarms of millions and practically killing plants of two or three weeks' growth. Older plants were considerably checked in development, but not destroyed. The next year beets were injured in South Carolina and Indiana.

This is one of our commonest, most nearly omnivorous, and most destructive flea-beetles. It measures about an eighth of an inch, is cream-colored, with nearly black abdomen and eyes, and striped wing covers (fig. 8, *b*). The larva is white and slender, with light brownish-yellow head. It is an American species and of rather wide distribution, from New Jersey and Pennsylvania southward to Georgia, and westward to California.

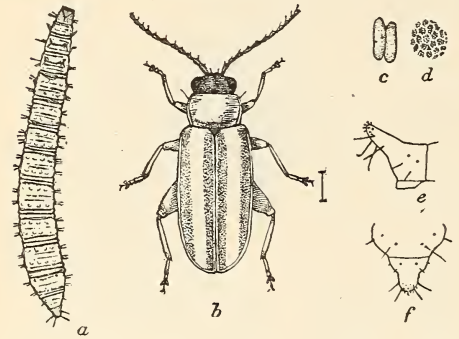

FIG. 8.—*Systena blanda: a*, larva; *b*, beetle; *c*, eggs; *d*, sculpture of egg; *e*, anal segment, from side; *f*, same from above—*a–d*, six times natural size; *e*, *f*, much enlarged (author's illustration, Division of Entomology).

The pale-striped flea-beetle, though a general feeder, is particularly fond of the foliage of beets and beans. Potatoes and corn it also injures very much, while considerable damage to melons and other cucurbits, turnips and other crucifers, tomatoes, peas, carrots, and eggplant has been observed. The beetles also attack strawberry, clover, cotton, oats, and peanuts, and injure the leaves of pear, as also pear grafts, by eating out the terminals, thus stunting the growth of the trees. They sometimes do severe injury in three or four days.

The species hibernates as a beetle, and appears above ground in the vicinity of the District of Columbia early in June; egg laying evidently continues through that month and to the middle of July, if not two or three weeks later; injury is usually due to the beetles upon their first appearance; and almost any valuable crop may be injured, either in the absence or presence of the wild food plants.

The larvæ live below ground, and have been observed by the writer and others feeding on the roots of corn, lambsquarters, and Jamestown weed. They probably live also on pigweed (Ambrosia), cocklebur (Xanthium), and other weeds, as the beetles are commonly found on these plants.

THE BANDED FLEA-BEETLE.

(*Systena tæniata* Say.)

The banded flea-beetle also frequently attacks beets, beans, and other vegetables, particularly in the West and Southwest. It has similar habits to the preceding species and similar structure; it was, in fact, until quite recently very generally confused with the pale-striped form, and many references to injuries by this species are really due to the latter. Like the latter it varies considerably as regards color and punctation. It is polished black, with white stripes. A common dark form of the beetle is shown in figure 9.[a]

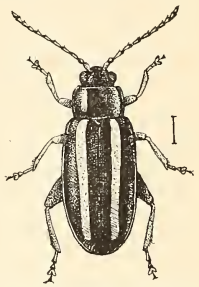

FIG. 9.—*Systena tæniata*, dark variety—about 6 times natural size (author's illustration, Division of Entomology).

THE RED-HEADED FLEA-BEETLE.

(*Systena frontalis* Fab.)

This species (fig. 10) resembles in its habits the two flea-beetles that have just been mentioned. Its color is shining black throughout except the major portion of the head, which is red. It has been known as an enemy of beets since 1891. It also attacks potato and beans, but is not restricted to vegetable crops, being quite fond of the foliage of fruits, including grape, gooseberry, pear, and others. It inhabits practically the entire arable region east of the Rocky Mountains, including southern Canada and the Southern States (Bul. 33, n. s., Div. Ent., pp. 111–113).

FIG. 10.—*Systena frontalis*—much enlarged (author's illustration, Division of Entomology).

THE SMARTWEED FLEA-BEETLE.

(*Systena hudsonias* Forst.)

From the red-headed flea-beetle this differs in being uniformly shining black. Otherwise the two species are very similar. Taken all in all, it is perhaps the most abundant of the flea-beetles which have been mentioned, but, although it shows a fondness for a number of crop plants, including sugar beet, potato, grape, beans, and sweet corn, it is much more confined to weeds (L. c., pp. 113–114).

The larval habits of the three species last mentioned have not been positively ascertained, but there is little doubt that they will be found to be much the same as those of the pale-striped flea-beetle, since the beetles of all of them occur in greatest numbers on the same species of weeds, and, even when occurring in moderate abundance, seem to show little preference.

[a] This and the preceding species are discussed in Bul. 23, n. s., Div. Ent., p. 23.

THE WESTERN CABBAGE FLEA-BEETLE.

(*Phyllotreta pusilla* Horn.) [a]

In some of the Western States not inhabited to any extent by any of the preceding species there is a small dark-colored flea-beetle uniformly deep polished olive green, with the surface irregularly punctate (fig. 11) which, as its English name indicates, affects more particularly cabbage and related crops. During 1901 it was observed doing considerable damage to sugar beet in portions of Colorado. It prefers the younger plants, and as instance of its destructiveness one grower reported that he had not raised a turnip for seven years on account of its ravages. Between 10 and 20 acres of corn were reported destroyed on one farm in twenty-four hours, the beetles sometimes coming in swarms like black clouds and covering the plants. This flea-beetle ranges from the Dakotas to Mexico, and westward to southern California, being found in numbers at high elevations in the Rocky Mountain region.

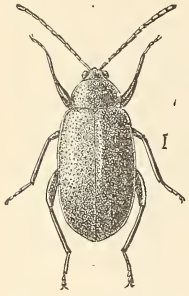

FIG. 11.—*Phyllotreta pusilla*—much enlarged (after Riley, Division of Entomology).

REMEDIES.

The arsenicals, especially Paris green, are the most useful remedies for leaf-feeding beetles, and since Bordeaux mixture is extremely distasteful to flea-beetles, this, if mixed with the insecticide and applied as a spray, is more effective than when the arsenical is used dry. Against some species, however, Paris green mixed with 20 parts of flour and dusted on infested plants has been found satisfactory, while kerosene emulsion and even strong soap washes have been found useful in combatting others. When the plants are quite young the spray can not be so well used as after they have attained larger growth, but the dry mixture can then be applied with best results. Bordeaux mixture used alone is valuable as a deterrent.

Clean culture is also of the greatest value. It consists in keeping down weeds which serve as food for the beetles and as breeding places for their larvæ. Against the spinach flea-beetle we have to destroy the chickweed and lambsquarters of the vicinity and to avoid the planting of beets and spinach in ground which has become overgrown with these plants. For the pale-striped flea-beetle, lambsquarters, cocklebur, and pigweed should be destroyed, while for insects like the smartweed flea-beetle practically all weeds in the vicinity must be pulled up and destroyed, as this insect feeds on nearly all forms of useless vegetation. The time for performing this work varies according to

[a] In early publications, for example, in the Report of this Department for 1884, p. 308, this insect was mentioned as *Phyllotreta albionica* owing to the fact that the two species had not been separated, *albionica* being the older name.

the species concerned, and with locality and season. In general terms, it may be said that the best time is after the beetles have laid their eggs and before the young or larvæ have attained full development. For most species this would be about three weeks after the first appearance of the beetles in numbers. A spraying of the upper surface is sufficient for most flea-beetles, but for the spinach flea-beetle it is necessary to apply a spray to both the under and upper surfaces in order to reach the larvæ which feed in exposure on the lower surfaces of plants.

THE BEET AND SPINACH CARRION BEETLES.

Among insects particularly attached to beet and spinach are two, known respectively as the beet and the spinach carrion beetles. They are nearly unique among carrion beetles (Silphidæ) which subsist chiefly on decomposing animal matter, this being the normal habit of the family. The two species in question are also found under carcasses and in garbage. From their dual habit of living both on carrion and on beets and spinach they derive their English names.

THE BEET CARRION BEETLE.

(*Silpha opaca* Linn.)

This species is mentioned in the preface as particularly attached to the beet. In some parts of Europe it is a very serious pest, more particularly in Germany, France, Austria, and England, although it is rather generally distributed on that continent, occurring in Siberia. In Germany it has been described as "by all odds the most troublesome pest" with which beet growers have to deal. The species was identified in 1880 from specimens collected in California and "Hudson Bay," and it seems probable that it was introduced on the Pacific coast, and has recently made its way to Nebraska, where it was found attacking beet in 1891.[a] There is some danger that at some future time it may become a more serious pest, such as it now is in its native home.

The beetle is black and of similar appearance to our common carrion beetles. The body is elongate, or oblong-oval, with the sides comparatively parallel. It is much flattened, and the elytra at the sides are thin and slightly reflexed or turned up. There is also a small prominence near the end of each, the middle costa or ridge of the elytron extends nearly to the posterior margin, and the tip of the abdomen is dull red. The length is about three-fourths of an inch.

The larvæ are shining black, and of similar appearance to our common sowbugs (Oniscus), creatures commonly found in fence corners and in cellars, and they, with their parents and others of their kind,

[a] Bruner, Bul. 30 (old series), Div. Entomology, p. 40.

occur under carcasses of small animals, such as rabbits and birds, and in garbage.

The eggs are probably laid usually in decomposing material, but it has not been ascertained where they are deposited in beet fields.

The larvæ are nocturnal, feeding chiefly in the evening and early morning, and concealing themselves during the heat of the day about the roots of the plants affected. They first attack the parenchyma or outer surface of a leaf, leaving the skeleton more or less intact; but when in numbers they consume entire leaves, sometimes eating them down to the ground. Afterwards they attack the roots. Where the leaves are not severely eaten the plants recover, but if the foliage is destroyed the plants usually die. The species is probably single-brooded. As soon as the larvæ become full fed injury ceases and the plants, if not too seriously damaged, begin to take on new growth. Larvæ descend into the soil to a depth of three or four inches and there change to pupæ and afterwards to beetles, in which stage they pass the winter undisturbed and free from natural enemies until the following spring, when they reappear.

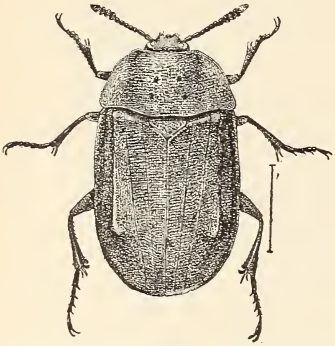

FIG. 12.—*Silpha bituberosa:* adult—much enlarged (original, Division of Entomology).

THE SPINACH CARRION BEETLE.

(*Silpha bituberosa* Lec.)

This species resembles the preceding, both in appearance and habits, but differs in some important particulars, being a native species and restricted, so far as injurious occurrences are concerned, to the Northwest Territories and neighboring portions of British America. It occurs, however, also in northern Kansas, from which State it was originally described in 1859, and in Wyoming and Montana. Unlike the preceding species, it attacks other vegetation than beets, although it seems probable that it fed originally on plants of that family, such as lambsquarters and another weed native to the Northwest (*Monolepis nuttalliana*). Other food plants are squash and pumpkin. The insect seems capable of being quite destructive to all of these crops. Some vines of the pumpkin have been entirely destroyed. In Alberta the larvæ have been reported as swarming in gardens in the spring, devouring leaves of spinach and beet.

The spinach carrion beetle (fig. 12) is much broader than the beet carrion beetle, being more nearly oval, whereas the latter is elongate oval. It measures nearly half an inch and is of the same black color. The larva is polished black and does not appear to have been differentiated from that of the preceding.

In its life history it doubtless closely resembles the European importation in feeding on both carrion and vegetation. Whether or not the beetles also injure plants does not appear to be known. Attack by the larva begins in the latter part of May, extending through June, and probably into July in the more southern and warmer range of the species.[a]

REMEDIES.

The remedies in use against the Colorado potato beetle are applicable to these carrion beetles. Paris green, applied either dry or in spray, as directed for leaf beetles, and clean culture are about all that are necessary, but it is also advised in the treatment of the native species that the weed Monolepis be sown in the vicinity of spinach, beets, and gourd crops subject to attack, to serve as a lure to draw the insects from the crops. On the trap plants they can be more easily destroyed, and by various means.

BLISTER BEETLES.

Blister beetles are among the most conspicuous of all enemies of the sugar beet, no less than a dozen species having been observed doing more or less injury to this crop. One or more species are generally found in beet fields, and, in fact, the arable regions of the United States are probably never free from them. In the East four or five species are common, and in the Southwest there are a few more extremely destructive species. Most blister beetles are better known as potato pests, but next after potatoes beets appear to be the favorite food of many of them. After this they attack other vegetable crops, some favoring beans, peas, and other legumes, while almost any of them will attack whatever comes next in their line of march. They are gregarious, congregating in great numbers, and some have the truly migratory habit, feeding voraciously, running with great rapidity, and flying from time to time. Thus it happens that they frequently descend in such numbers on a field that an entire crop is ruined beyond recovery in a few days, when the insects disappear and are perhaps seen no more until the following year. After the departure of one species of blister beetle another frequently follows, to be replaced by a third, and so on.

Some species, though apparently very destructive, appear so late in the season that, although beet plants are sometimes nearly defoliated, a fair crop may be gathered in spite of the loss of the leaves, a new growth of which is sometimes put forth. The roots, morever, are not touched.

[a] General accounts of this insect have been published by Dr. James Fletcher. (Rept. Ent. Can. Exp. Farms for 1893 [1894], pp. 20, 21; for 1897 [1898], page 198, etc.)

In their life history blister beetles differ greatly from other Coleoptera in that they undergo a more complicated series of metamorphoses which will be explained and illustrated in the account of the striped blister beetle which follows.

Blister beetles are not an unmixed evil, since they do some good in their larval stage to compensate in a measure for the harm the beetles occasion to our crops, for the habit of the larvæ of destroying grasshopper eggs renders them of material aid in keeping these pernicious insects in check. This is especially true in the Western States, where both blister beetles and grasshoppers abound. But the benefits derived are really more than counterbalanced by the losses occasioned in fields and gardens; hence, insecticides and other measures should be employed to destroy the beetles when they occur in harmful numbers.

As blister beetles are to be found in practically all fields of sugar beet, and are among the most prominent enemies of this plant, it is purposed to consider several of the most abundant species.

THE STRIPED BLISTER BEETLE.

(*Epicauta vittata* Fab.)

Before the advent of the Colorado potato beetle in the East this was our most destructive potato insect, and probably because it is also

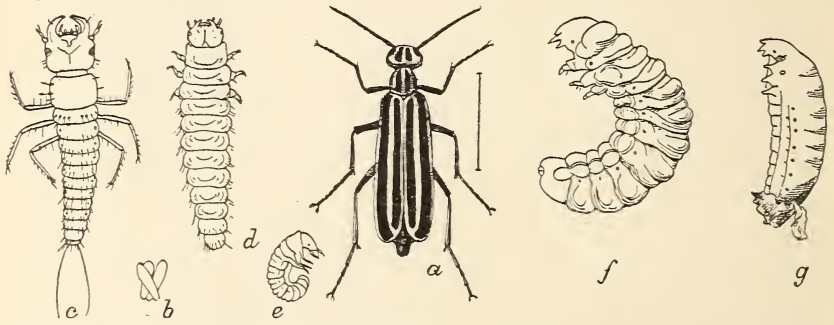

FIG. 13.—*Epicauta vittata: a*, female beetle; *b*, eggs; *c*, triungulin larva; *d*, second or caraboid stage; *e*, same as *f*, doubled up as in pod; *f*, scarabæoid stage; *g*, coarctate larva—all except *e* enlarged (after Riley, except *a*; original, Division of Entomology).

striped is often called the "old-fashioned potato bug." It is abundant and well known east of the Rocky Mountains, of common occurrence on sugar and table beets, and as its life history is typical of injurious forms of this group it may properly receive first attention. The beetle can be easily identified by means of the illustration (fig. 13, *a*). It is about half an inch long, and there are two black stripes on each wing-cover, alternating with yellow.

The eggs are laid in small masses (*b*) on plants or upon the ground. From each hatches a small long-legged larva, called a "triungulin" (*c*), which runs actively about in search of a grasshopper egg pod, which

it enters and devours the contents. After a time it casts its skin and assumes what is termed the "caraboid" or second larval stage (*d*, *e*); and with another molt it resembles a white grub, the "scarabæoid" larval stage (*f*). When a larva has finished its quota of locusts' eggs it undergoes a fourth molt and forms within its own skin what is known as the coarctate larval stage (*g*), and in this condition usually passes the winter. In the spring another larval molt takes place, and with the last shedding of its skin the insect enters upon the true pupal stage, and in due time transforms to a beetle.[a] The pupa of a related species is illustrated in figure 16.

This species also does injury to beans, peas, tomato, turnip, radish, melons, corn, clover, and alfalfa. It was the cause of a serious outbreak in Michigan in the latter part of June and the first part of July, 1900. Corn plants about six inches high and clover suffered severely, the reason being that the potatoes grown there, being all late varieties, had not come up, and more palatable food was not available.

The writer has seen hordes of this species traveling in much the same manner as army worms, and feeding with such voracity that scarcely a beetle flew when plants on which they were congregated were approached. When a "flock" starts to feed on one form of food plant it continues on this until all plants in sight have been devoured, when the beetles have recourse to other plants that are palatable to them. This trait has also been observed in other species, especially in the margined blister beetle.

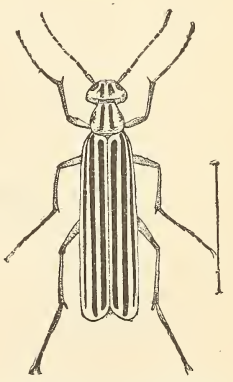

FIG. 14.—*Epicauta lemniscata*—enlarged (original, Division of Entomology).

THE THREE-LINED BLISTER BEETLE.

(*Epicauta lemniscata* Fab.)

This blister beetle very closely resembles the preceding; in fact, the two are frequently confounded, and injuries inflicted by one species are apt to be attributed to the other. The form under consideration (fig. 14) is a little more slender than the striped blister beetle, has three stripes on each wing-cover instead of two, and is a little longer. It is very abundant southward, and, although perhaps primarily a potato pest like most of our noxious blister beetles, is also extremely fond of beets. During different years we have received complaints of this species and of extensive damage in Florida, South Carolina, and Texas to cabbage, potato, squash, and to beet tops, as also to alfalfa. In the vicinity of Horton, Tex., in 1896, the last-mentioned crop was said to be a failure, owing to the depreda-

[a] Particulars in regard to these peculiar transformations are given in articles by C. V. Riley, Am. Nat., Vol. XII, p. 286; Vol. XVII, p. 790.

tions of this blister beetle. During 1902 we received reports of injuries by it in Florida to tomato, potato, sweet potato, eggplant, turnip, cabbage, cowpea, and beet, beet tops being preferred to all other vegetables.

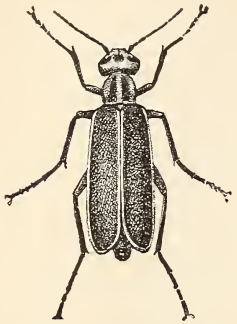

FIG. 15.—*Epicauta marginata*—enlarged (original, Division of Entomology).

THE MARGINED BLISTER BEETLE.

(*Epicauta marginata* Fab.)

One of the commonest Eastern species is the margined blister beetle (figs. 15 and 16). In the writer's experience it appears to be more partial to beets than to any other useful plant. Entire plantings are often seen almost completely defoliated. In a climate like that of the District of Columbia, it occurs so late that no material harm is done, the roots having made nearly complete growth when the insect appears in its greatest abundance, in late July and in August. It is known as an important enemy of beans, potato, and tomato, and attacks aster, clematis, and other ornamental plants.

FIG. 16.—*Epicauta marginata*: pupa—enlarged (original, Division of Entomology).

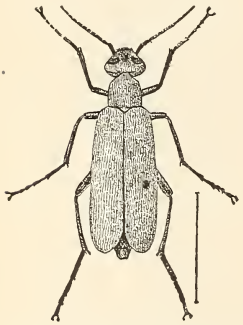

FIG. 17.—*Epicauta cinerea*—about twice natural size (original, Division of Entomology).

THE GRAY BLISTER BEETLE.

(*Epicauta cinerea* Forst.)

This species (fig. 17) is of the same form and general structure as the preceding, but is of a uniform gray color, lacking the sutural and lateral margins which give the name to the margined blister beetle. The habits of the two species are practically identical; in fact, the latter is believed by some to be only a variety of the margined species.

FIG. 18.—*Epicauta maculata*—nearly three times natural size (original, Division of Entomology).

THE SPOTTED BLISTER BEETLE.

(*Epicauta maculata* Say.)

The southwestern portion of the United States is the home of many species of blister beetles not found in the North and East. Among the most abundant of these is the spotted blister beetle (fig. 18). Its body is covered with fine gray hairs, with small rounded areas on the elytra, through which the

natural black of the body shows, giving it the appearance of a gray insect finely dotted with black. It is more or less abundant from Texas and New Mexico northward to South Dakota, and in California and Oregon. It has been known as a beet pest since 1875,[a] and was reported very generally upon sugar beet, potato, and clover in South Dakota in 1897.[b] In August, 1902, Mr. J. L. Webb observed numbers eating leaves of beet at Elmore, S. Dak.

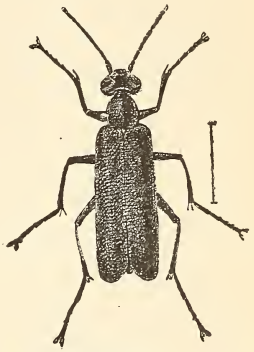

FIG. 19.—*Epicauta pennsylvanica*—enlarged (original, Division of Entomology).

THE BLACK BLISTER BEETLE.

(*Epicauta pennsylvanica* De G.)

The black blister beetle (fig. 19) is a familiar object to nearly everyone from its occurrence on golden-rod, aster, and related wild plants, while the farmer is quite too well acquainted with it as an unwelcome visitor to his potato patch and to various other vegetables. Florists know it under the name of "aster bug," from the severe injuries which it does to asters and which they are unable entirely to prevent. It is uniformly black, without polish, and its length varies from a little more than a quarter to half an inch. It is well distributed in the region east of the Rocky Mountains, and does most injury between the Atlantic States and Texas. Its time of appearance is more or less coincident with the blossoming of the golden-rod, from June to October according to locality, and as a rule it appears later than other species. It is one of the worst insect enemies of potato, beet, and aster, and is also destructive to carrots, beans, cabbage, corn, mustard, clematis, zinnia, and other flowering plants.

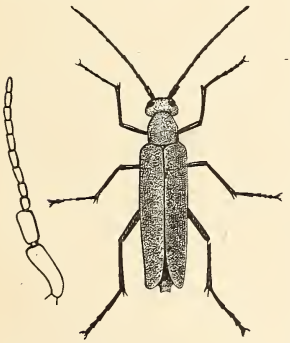

FIG. 20.—*Macrobasis unicolor:* female beetle at right, twice natural size; male antenna at left, greatly enlarged (author's illustration, Division of Entomology).

THE ASH-GRAY BLISTER BEETLE.

(*Macrobasis unicolor* Kby.)

This is one of our commonest Eastern species (fig. 20), and although most destructive to beans, peas, and other leguminous plants, is also a serious enemy of beets, potato, and tomato, and attacks besides sweet potato and some flowering plants.[c]

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[a] Packard, U. S. Geol. Surv. for 1875, p. 731.

[b] D. A. Saunders, Bul. 57, So. Dak. Agl. Ex. Sta., p. 52.

[c] Yearbook U. S. Dept. Agr. for 1898, pp. 249–250.

THE IMMACULATE BLISTER BEETLE.

(*Macrobasis immaculata* Say.)

As with some of the following species, this insect, although common, has not been much studied; but we know of its having injured beets in Kansas as early as 1897, and during 1902 it was destructive to sugar beet in Colorado. Among other food plants are potato, tomato, and cabbage. It is one of our largest blister beetles, and is gray or yellow in color.

THE TWO-SPOTTED BLISTER BEETLE.

(*Macrobasis albida* Say.)

During 1902 this blister beetle was destructive in Indian Territory, in one case devouring a field of sugar beets in a single day. Although an extremely common species from Kansas to Texas and New Mexico, little has been published in regard to its habits until very recently. Like others of its kind it favors vegetable crops, which include tomato, potato, and some others. It is evidently an old beet enemy, as we have record of its being very injurious to this crop in Kansas a decade earlier than the case reported.

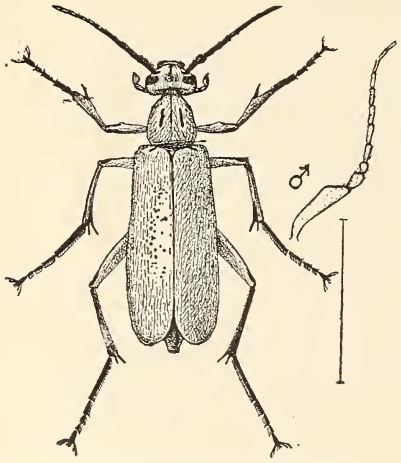

FIG. 21.—*Macrobasis albida:* twice natural size (original, Division of Entomology).

This is also a large species (fig. 21), gray or yellowish in color, with the thorax marked with two nearly parallel lines. It measures about an inch or an inch and a half in length.

THE SEGMENTED BLACK BLISTER BEETLE.

(*Macrobasis segmentata* Say.)

Injury by this blister beetle to beets was reported to this office in 1897, when a considerable proportion of crops of beets, as well as potato, tomato, and cabbage, was being destroyed in Kansas, the beetles being described as coming in large swarms, settling down in fields, and devouring and ruining crops in a few hours. It is one of the larger species of the group, sometimes attaining a length of about an inch. It is of robust form, uniformly dull black, except for an occasional narrow fringe of cinereous hairs on the base or apex of the thorax. Its range extends from Kansas well into Mexico.

NUTTALL'S BLISTER BEETLE.

(*Cantharis nuttalli* Say.)

This species has several times been noted as injuring beets. The beetle (fig. 22) is large and beautiful, usually of a bright metallic green, the head and thorax having a coppery luster, the wing-covers often purple. Its habitat extends from the Mississippi region to the Rocky Mountains and from Canada to Nebraska.[a]

Notes on the habits of this and several other species which have been considered are published in Bulletin No. 40 (new series) of the Division of Entomology (pp. 114–116).

REMEDIES.

Paris green is one of the best remedies for blister beetles when they occur on beets, potatoes, and most other crops. It may be applied dry, mixed with 10 to 20 parts of flour, plaster, or air-slaked lime, or in the form of a spray, also mixed with lime or Bordeaux mixture, at the rate of a quarter of a pound of the poison to 40 gallons of the diluent. Repeated applications are sometimes necessary, since the poisoned beetles are replaced by others.

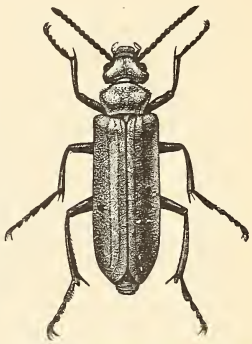

FIG. 22.—*Cantharis nuttalli:* female beetle, one-third larger than natural size (author's illustration, Division of Entomology).

Owing to the rapidity with which many species work, frequently in swarms of thousands, poisons are of little value. We must, therefore, resort to mechanical measures for their destruction, and in the employment of these promptness and thoroughness are the essentials. A remedy which is employed with success in the Western States consists in sending a line of men and boys through infested fields to drive the beetles before them until they alight on a windrow of hay, straw, or other dry vegetable material which has previously been prepared along the leeward side of the field. When the beetles have taken refuge in such a windrow, it is fired and the beetles are burned. The beetles may be destroyed by sweeping them into a net, such as is used by insect collectors, and throwing the captured insects into a fire; or by beating them into large pans of water on which there is a thin scum of coal oil. The latter remedy is successful over small areas.

After what has been said concerning the voracity of these beetles it is almost superfluous to add that whatever remedy is employed should be applied at the outset of attack in order to be of substantial value.

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[a] Yearbook U. S. Dept. Agr. for 1898, pp. 250–251.

SNOUT-BEETLES OR WEEVILS.

A few species of snout-beetles or weevils have been observed attacking sugar beet at various times, but with the exception of the imbricated snout-beetle these insects are of little importance as beet pests; in fact, only one species other than that habitually does material harm to beet plants. The species in question (*Tanymecus confertus* Gyll.) was once notably injurious to sugar beet in Nebraska. It was observed by Professor Bruner first on cocklebur, lambsquarters, and smartweed, after devouring which it completely destroyed the beets in a 12-acre field. Injury by this class of insects in beet fields is by the beetles, the larvæ feeding on the roots of weeds and wild plants.

THE IMBRICATED SNOUT-BEETLE.

(*Epicærus imbricatus* Say.)

The imbricated snout-beetle is a common insect of the field, garden, and orchard, and capable of committing considerable injury to a variety of useful plants including sugar beet and various other vegetables, such as beans and pease.

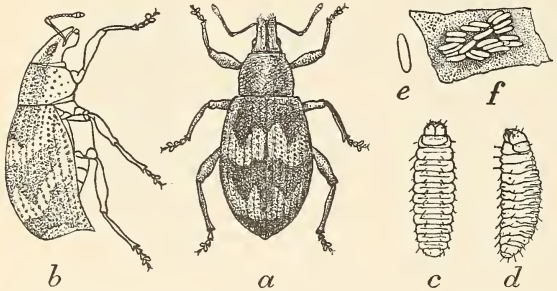

FIG. 23.—*Epicærus imbricatus: a*, female beetle; *b*, same from side; *c*, newly hatched larva; *d*, same from side; *e*, egg; *f*, egg mass.—*a*, *b*, about three times natural size; *f*, two times; *c*, *d*, *e*, more enlarged (author's illustration, Division of Entomology).

It is one of our largest snout-beetles, measuring nearly half an inch in length, and has the body covered with minute imbricated scales (whence the insect's name), the lighter portions appearing brownish gray, and the darker light brown, forming a pattern as shown in figure 23, *a*, and *b*. The head is prolonged into a short broad snout, with elbowed antennæ and the elytra or wing covers terminate in a point. Both sexes are wingless.

It is well distributed, occurring in most States, except the more northern ones, east of the Rocky Mountain range. It does not appear to be found north of the Upper Austral life zone. This distribution includes localities from the neighborhood of New York City southward to Texas and westward to Colorado and Utah.

In addition to the plants that have been mentioned as furnishing food for this species, it has been observed doing more or less injury to onion, radish, cabbage, cucumber, watermelon, muskmelon, squash, corn, potato, and tomato, among vegetables; apple, cherry, and pear trees; raspberry, blackberry, and gooseberry bushes; and to feed on grasses and clover, and some forms of weeds.

The larva is subterranean in habit, but the mature larva and the pupa are unknown, as is also the larval food plant. A female beetle kept by the writer from May till July deposited eggs almost daily, 540 in number, and it was not known how many eggs had been laid prior to that time. The beetle possesses the habit so common to snout-beetles of "playing 'possum" or feigning death when disturbed, dropping off its food plant on the slightest disturbance and remaining for some time before resuming activity. [a]

A beetle parasitized by a fungus (*Sporotrichum globuliferum ?*) is illustrated in figure 24.

The imbricated snout-beetle is one of many species of insects which are sporadic as regards injurious attack and troublesome only in seasons following a year which has been favorable to the increase of individuals. The beetles are not restricted to wild plants even in years of scarcity, but are found over the area which they inhabit on cultivated or other useful plants every year. Fortunately the beetle is not only irregular as to destructive occurrences, but is omnivorous as well, subsisting on one plant quite as well as another, thus distributing attack.

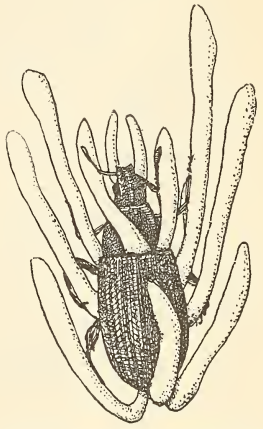

FIG. 24.—*Epicærus imbricatus:* beetle attacked by fungus—three times natural size (author's illustration, Division of Entomology).

Remedies.—This species will yield to the same remedies in use against the Colorado potato beetle. On plants resistant to arsenicals, such as potato, Paris green applied as a spray at the rate of a pound to 100 gallons of water is effective, while on less resistant plants, such as peach and bean, a weaker spray—about 1 pound to 150 gallons of water—or one in which arsenate of lead is the poison, is necessary to avoid scalding the foliage. Arsenicals can also be used dry, mixed with about 10 parts of cheap flour or lime, and applied to the infested plants by means of a hand bellows.

The beetles may be readily dislodged from affected plants by jarring them with a pole or stick upon "curculio catchers" of strong cloth stretched on frames and mounted on wheels or runners. If the cloth is saturated with kerosene, it will kill them; or, as they make little or no effert to escape, they may be easily taken from the "catchers" and killed by burning or by pouring scalding water over them.

Eventually this snout-beetle will probably become rare owing to its being wingless, when it may be replaced by other species having well developed wings.

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[a] A more detailed account is given in Bul. 19, n. s., Div. Ent., pp. 62–67.

CUTWORMS.

These insects are among the most troublesome with which the vegetable grower has to deal, but, although often associated with injury to sugar beet, they as a rule show no preference for this plant. Hence they are of little importance save under exceptional circumstances, when they attack newly planted crops. They are usually present in most gardens and fields, and it is a question of their appearance in numbers and at the time of the year when the plants are just beginning to grow, as to whether they will prove sufficiently destructive to require remedial treatment. They are likely to attack any portion of a beet plant—foliage, flowers, stalks, fruits, or roots—and when they are sufficiently abundant to migrate like army worms they can be quite injurious.

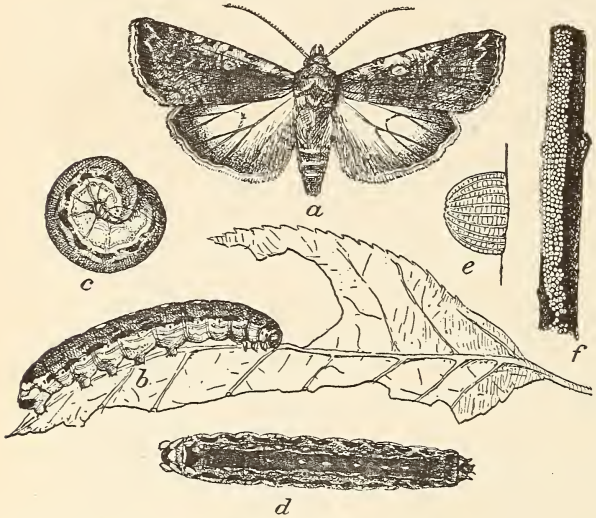

FIG. 25.—*Peridroma margaritosa:* *a*, moth; *b*, normal form of larva, lateral view; *c*, same in curved position; *d*, dark form, dorsal view; *e*, egg from side; *f*, egg mass on twig (after Howard, Division of Entomology).

Although we have two or three score of injurious cutworms, not more than half a dozen of these have been reported to be seriously troublesome to sugar beet. The different species vary considerably as to life and other habits, but in this connection brief mention will be made of only a few of the most important insects of this group.

THE VARIEGATED CUTWORM.

(*Peridroma margaritosa* Haw. [*saucia* Hbn.].)

There is little doubt that this is the most important and widely known of all cutworms. It is cosmopolitan and likely to be found anywhere, and although it favors vegetable crops it is able to eke out an existence on almost any form of vegetation. The progenitor of this cutworm is a rather large grayish-brown moth or "miller," and the full-grown cutworm measures about $1\frac{3}{4}$ inches. It is variable, like the moth, some forms being pale and others darker. The usual ground color is rather dull brown, mottled with gray and smoky black above, the characteristic feature consisting of a row of four to six yellow

medio-dorsal rounded spots. The different stages are shown in figure 25. During the severe outbreak of this species in 1900, already mentioned, practically all forms of vegetables, including sugar and table beets, were attacked, the insect even eating into roots and tubers and devouring the foliage and gnawing the bark of trees.

A detailed account of this species is furnished in Bulletin 29, new series, Division of Entomology.

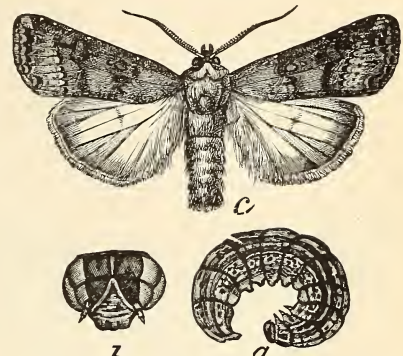

FIG. 26.—*Agrotis ypsilon*, a beet cutworm: *a*, larva; *b*, head of same; *c*, adult—somewhat enlarged (fom Howard, Division of Entomology).

THE GREASY CUTWORM.

(*Agrotis ypsilon* Rott.)

This species is commonly found in fields of beets, and may be selected as typical of its class. In importance as a pest it is perhaps second only to the variegated cutworm. It is of about the same size (fig. 26), and of a dull, dirty brown color, characteristic of most cutworms, with the lower portion paler and greenish, and the entire surface of a greasy appearance, whence the name. It is cosmopolitan, and has a most emphatic and pernicious cutting habit. It is especially troublesome to newly set tomato plants, to potato, corn, lettuce, and tobacco.

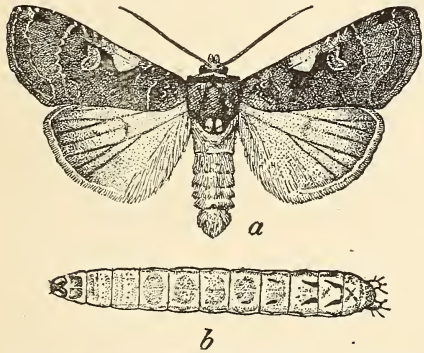

FIG. 27.—*Noctua c-nigrum: a*, moth; *b*, larva—somewhat enlarged (author's illustration, Division of Entomology).

THE SPOTTED CUTWORM.

(*Noctua c-nigrum* Linn.)

This is one of our commonest and most destructive species, and is commonly found on beets. It resembles the variegated cutworm in being cosmopolitan, nearly omnivorous, a climbing species, and in migrating in numbers like the army worms. The moth (fig. 27, *a*) has brown forewings, tinged with red or purplish and marked with lighter colors as figured. The cutworm (*b*) is pale brown or gray, sometimes whitish with greenish or olive tints, and has the last segments marked with oblique black lines. It measures, fully extended, about an inch and a half. The principal crops which it has been known to injure include, besides beets, corn, and other cereals, cabbage, cauliflower, turnip, pea, carrot, tomato, celery, rhubarb, currant, gooseberry,

clover, violets and some other ornamental plants. It has been noticed attacking grasses and oats, but does not appear to resort to these plants when more choice food is at hand.

THE WESTERN ARMY CUTWORM.

(*Chorizagrotis agrestis* Grote.)

In 1897 this cutworm, which had hitherto led an unpretentious existence in the Missoula Valley, Montana, developed in great numbers, and a serious outbreak followed. According to the account given by Dr. E. V. Wilcox (Bul. 17, Montana Agl. Exp. Sta., 1898), this visitation resembled that of the common army worm, and the list of observed food plants shows that it can be a very serious vegetable pest, since, besides beets, it attacks cabbage, horse-radish, radish, mustard, turnip, pea, tomato, potato, onion, celery, rhubarb, corn, cereals, grasses, clover and other forage crops, forest and fruit trees, and bush fruits.

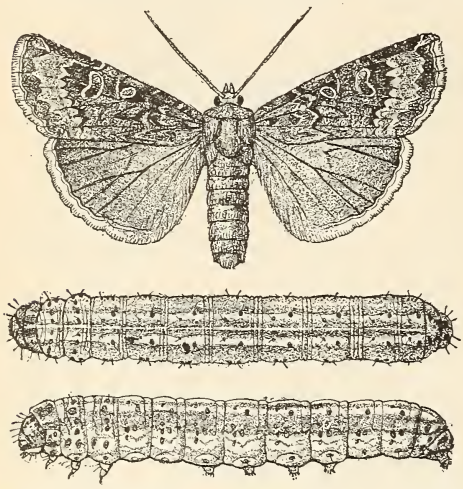

FIG. 28.—*Chorizagrotis agrestis:* moth above; larva, dorsal view, in center; larva, ventral view, below—somewhat enlarged (original, Division of Entomology).

This cutworm (fig. 28) is of the ordinary type, and attains a length of 2 inches when mature. Its body is nearly smooth, only a few short hairs being observable. The color varies from pale green to dark brown. Along the sides there are alternating longitudinal light and dark bands. The moth is brown with gray markings, has a wing expanse of about 1¼ inches, and is quite variable.[a]

The recorded distribution comprises Kansas, Nebraska, Texas, New Mexico, Arizona, Colorado, Montana, and California.

Although the injuries committed in 1897 have not to our knowledge been duplicated, reports have reached us of the occurrence of great numbers of the species in widely separated localities, the moths flying about in such numbers as to become annoying pests in dwellings. Such reports were received from Missouri in 1902, and from Arizona and Colorado in 1903. In Montana a "wild sunflower" (*Balsamorrhiza sagittata*) and avens (*Geum triflorum*) are favorite food plants, but in other localities it seems probable that the natural

[a] This species is so often accompanied by two related forms, more particularly by *Chorizagrotis introferens* Grote, as to give rise to the supposition that all are colorational varieties of the same species, the truth of which will probably be established by rearing from selected females.

food, as with so many other forms of cutworms, consists of wild grasses of little or no value, and when grasses or weeds are replaced by crops these are apt to be attacked, under favoring conditions.

THE COTTON CUTWORM.

(*Prodenia ornithogalli* Guen.)

This species, although called a cutworm, has little in common with preceding species, being more distinctly marked, more or less diurnal in habit, and in having the cutting trait somewhat feebly developed. In fact, it more nearly resembles the boll worm in its habit of boring into the bolls of cotton and the fruit of tomato. It is a very common species, but as a rule not especially destructive, as it is more solitary than the common cutworms. It has been observed attacking and doing more or less injury to beets, potato, asparagus, cabbage, cucumber, peach, and cottonwood. It is also common on violet, morning-glory, and other ornamental plants, and on weeds, and is frequently found in greenhouses.

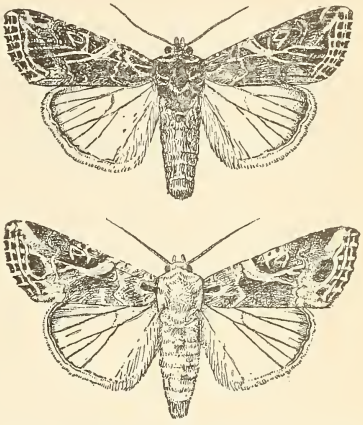

FIG. 29.—*Prodenia ornithogalli:* dark form, male, above; pale form, female, below—somewhat enlarged (original, Division of Entomology).

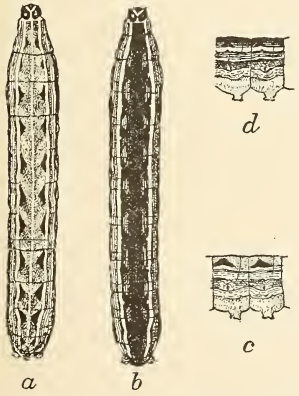

FIG. 30.—*Prodenia ornithogalli: a*, pale form of larva; *b*, dark form of same; *c*, lateral view of abdominal proleg segments of pale form; *d*, same of dark form—all enlarged (original, Division of Entomology).

The moth has a wing expanse of a little less than 1½ inches, and is quite distinct from any which have already been considered, the fore-wings having a more complicated pattern. There is much variation in the colors, which has caused differently colored varieties to be described as species. Two extreme forms are shown in figure 29. That they are mere colorational varieties of one species has been proved by the writer by rearing both from an egg mass deposited by a single female (Bul. 27, new series, Div. Ent., pp. 64–73, 114).

The larva is subject to the same variation as the moth. The ground color is generally olive or greenish brown, finely lined with dark gray and brown, while the upper surface is ornamented with a double row of velvety black or greenish spots, which give it a striking appearance. A pale form of the larva is shown in figure 30 at *a* and a darker form at *b*. It is a singular fact that in the writer's experiments the pale larva produced the dark form of moth and the dark larva the

lighter moth. The distribution of this species is wide, including the territory from Massachusetts to the Gulf, and westward to California, but it occurs in greater numbers southward. In the northern portion of its range it is occasionally killed off by exceedingly cold winter temperatures, as happened in 1899. The larvæ are found abroad from April to November. As with other species which have apparently come northward from the Gulf region, this species is most destructive in the autumn of the year. It is credited with being double-brooded, and possibly three generations are produced in the South. Larvæ have been observed by the writer to complete their development in a month, and the pupal period varies from 12 to 25 days. The winter is evidently passed in the pupal condition, in which respect this species differs from the ordinary cutworm.

THE GREEN BEET LEAF-WORM.

(*Peridroma incivis* Guen.)

In certain years and localities, as in Illinois in 1899 and 1900, this species is more abundant on beet leaves than any other caterpillar. It feeds on both surfaces of a leaf, and has been observed eating purslane, which is doubtless its natural food plant.

The larva, also called green cutworm, is green with a white or pinkish stripe on each side of the body. The species is generally distributed, and quite common in Illinois and Kentucky, where it is apparently double-brooded.

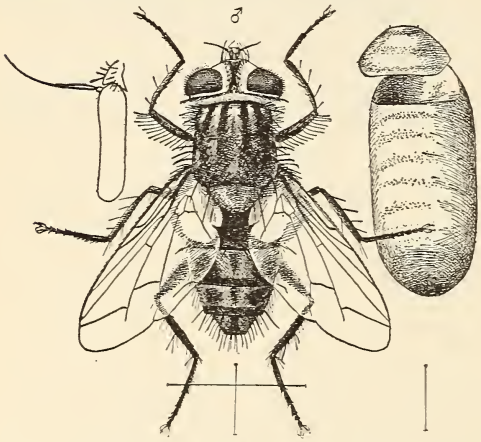

FIG. 31.—*Euphrocera claripennis*, a common cutworm parasite: adult with puparium at right and enlarged antenna at left (from Howard, Division of Entomology).

NATURAL ENEMIES.

Cutworms are exposed to a great variety of natural enemies, but as a rule these are not efficient checks except when the cutworms appear in great numbers and travel like the army worms. At such times many species of predaceous and parasitic insects and predatory mammals and birds, wild and domestic, destroy them in great numbers. Of the predaceous enemies ground beetles are most abundant, while the parasites include numerous species of ichneumon and tachina flies and a few chalcis flies. A common species of tachina fly is shown in figure 31. Cutworms are also subject to a fungous disease *Empusa aulicæ*. Among birds which are beneficial by feeding upon cutworms are robins, crows, the bluebird, and the bluejay, and among domestic animals are chickens, ducks, turkeys, Guinea fowls, and hogs.

From what has been said of the utility of domestic fowls and other animals it is obvious that with proper judgment their services would save great losses that it might otherwise be difficult to avert.

Poisoned baits are the standard remedies against cutworms, and to be most effective they should be applied as soon as attack is noticed. They are particularly valuable in cases where the direct application of insecticides to a plant is impossible owing to the danger of poisoning persons or stock when it is used for food. There are two kinds of bait—fresh vegetable and bran mash.

Vegetable bait may be prepared as follows: Spray a patch of clover, pigweed, or some useless succulent plant that grows by the roadside or in fence corners, with Paris green, 1 pound to 150 gallons of water; mow it close to the ground, and place it while fresh in small heaps about the infested plants at intervals of a few feet. The later in the day this can be done the better, as the material keeps fresh longer and the cutworms feed almost exclusively at night. Owing to the wilting of this bait, particularly in dry, sunny weather, it is advisable to cover each heap with a chip, shingle, or bit of bark for its protection against the sun's rays.

Bran mash or bran-arsenic mash is of equal value to a fresh vegetable bait, and, according to some, still more efficacious. Paris green, arsenoid, white arsenic, or in fact any arsenical can be used for poisoning this bait, and in its preparation, on account of the weight of the poison and the fact that it soon sinks to the bottom of the water when stirred, it is best first to mix the bran with water and sugar and then add the poison. The proportions are 2 or 3 ounces of sugar or a similar quantity of glucose or molasses to a gallon of water and a sufficient amount of bran (about a pound per gallon) to make, when stirred, a mixture that will readily run through the fingers.

Before planting a crop it is advisable to employ such bait, and its perfect success is assured by having the ground bare, which practically compels the cutworms to feed upon it.

Bordeaux mixture.—This fungicide has been recently tested against the variegated cutworm upon potato vines and asparagus. It was sprayed on as a remedy for blight, and it was discovered that the plants thus treated were free from attack. The use of this fungicide as a cutworm deterrent is certainly advisable. In any case, it should be used as a diluent for whatever arsenical is used.

Hand methods.—On some plants it is next to impossible to apply any but hand methods with good results. Experiments in Washington State during the season of 1900 demonstrated conclusively that in some cases it required less time to shake or brush cutworms from affected plants than to destroy them by spraying or otherwise.

"*Back firing*," a somewhat old-fashioned practice, is of great use in destroying army worms, cutworms, and other forms of insects when they occur in such numbers as to ruin a crop. It consists in burning a rather wide stretch in advance of the wind at the farthest extremity of the field, and then stamping this out to prevent the fire from reaching other fields beyond. The field is then burned, beginning with the side from which the wind is blowing. This has the effect of destroying the entire field, with all the cutworms and many other insects which it contains, with practically no danger of the fire spreading to fields where it is not desired.

When cutworms assume the habit of traveling in armies they should be treated in the same manner as advised against the army worms.

ARMY WORMS.

In addition to the army cutworm that has been mentioned and the variegated and spotted cutworms, which sometimes exhibit the same migratory tendency, there are three important species of beet-feeding caterpillars, allied to the cutworms, but lacking the true cutworm habit. The most important of these is the beet army worm.

THE BEET ARMY WORM.

(*Caradrina* [*Laphygma*] *exigua* Hbn.)

In the year 1899 this species, which had not previously attracted attention by its ravages, became prominent as an enemy to the sugar beet in Colorado. Subsequent study showed that it had been observed at an earlier date attacking crop and other plants in New Mexico and in California. It is an imported pest, and, although not at the present time of great importance, bids fair, in course of time, to become a serious enemy to the cultivation of sugar beet in America. It has evidently come by way of California and is traveling eastward, a method of migration of which there is precedent in the Colorado potato beetle.

The moth (fig. 32, *a*) is mottled gray, resembling the plain form of the related fall army worm. The fore-wings are broader and paler, and the reniform and other markings are more distinct. The wing expanse is less than an inch and one-half. The larva is rather slender, with a small head, and the body greenish or olivaceous and striped as shown (fig. 32, *b*, *c*, and fig. 33).

When migrating, the beet army worm attacks several forms of vegetation. Sugar beet appears to be the favorite host plant; table beets are also relished, and it feeds quite as well on lambsquarters, pigweed, and saltbush (Atriplex). When numerous, corn, potato, pea, onion, sunflower, and the leaves of apple, mallow, *Nicotiana glauca*, Cleome, plantain, and wild grasses are eaten. In southern California the moths appear in April and until June; caterpillars of the first generation

develop as early as the last week of May and a month later in June. In the cooler climate of Colorado and New Mexico larvæ have been noticed about the middle of June, becoming more abundant in August, when the greatest damage is done. From our somewhat incomplete knowledge of this species it appears that it has a spring and late autumn generation in Colorado and New Mexico, and perhaps a third in southern California, and it is evident that the second generation is generally most destructive.[a]

Methods of control.—Several remedies have been employed in Colorado with satisfactory results. These include Paris green and kerosene emulsion, both of which killed the insects and checked their numbers for the following year. Paris green was applied as a spray and dry, mixed with flour. With flour it cost about 80 cents an acre.

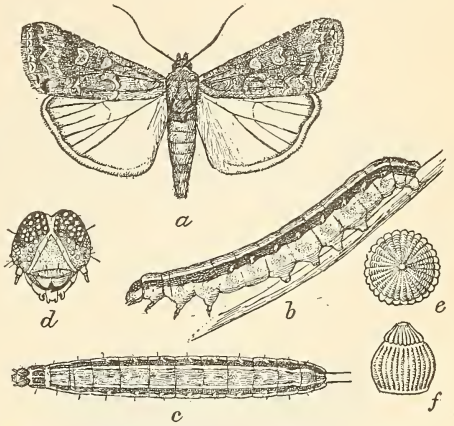

FIG. 32.—*Caradrina exigua: a*, moth; *b*, larva, lateral view; *c*, larva, dorsal view; *d*, head of larva; *e*, egg, viewed from above; *f*, egg, from side—all enlarged (*e,f*, after Hofmann; *a–d*, after Chittenden, Division of Entomology).

Two sprayings with the liquid preparation were most effectual. When this species is unduly abundant it should be treated in the same manner as the fall army worm (*Laphygma frugiperda* S. & A.), which is quite often associated with injury to sugar beet. The latter attacks nearly all forms of vegetable and other crops, but as it is discussed fully in Bulletin 29, new series, Division of Entomology, further mention is unnecessary here.

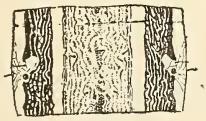

FIG. 33.—*Caradrina exigua:* enlarged section of first proleg segment, dorsal view (original, Division of Entomology).

A third species, the true army worm (*Leucania unipuncta* Haw.), is more strictly an enemy of cereals and grasses, and not, as a rule, of much importance as a beet feeder. Remedies are considered in Circular No. 4, Division of Entomology, and short general accounts of both the true army worm and the fall army worm are furnished in Farmers' Bulletin 132.

WEBWORMS.

Among insects that are nearly always to be found in their natural habitat in fields of beets are two small caterpillars known as webworms. Of these the sugar-beet webworm is a prime beet pest, and the second, known as the garden webworm, is a general feeder, devel-

[a] In a more complete consideration of this species, Bul. 33, new series, Div. Ent., pp. 37–46, references to economic articles by C. P. Gillette and others are furnished.

oping on weeds related to beets and invading cornfields and vegetable gardens when the supply of wild food plants and weeds is scant. Still a third species, the imported cabbage webworm, occasionally occurs on beets, but, as its name indicates, it is a cabbage pest, properly speaking, and does not resort to other plants when Cruciferæ are available.

THE SUGAR-BEET WEBWORM.

(*Loxostege sticticalis* Linn.)[a]

Although primarily a sugar-beet insect, this species, like many others that have been treated, is a periodical pest, and, as it is an introduction from abroad and widening its range, there is likelihood that it will in time assume greater economic importance. It is cousin to the native garden webworm, but the moth is larger, darker colored, and the markings are somewhat more pronounced. With the

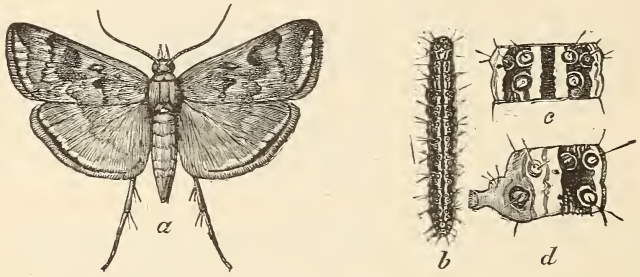

FIG. 34.—*Loxostege sticticalis: a*, moth, twice natural size; *b*, larva, less enlarged; *c*, upper surface of first proleg segment of larva; *d*, side view of same; *c*, *d*, more enlarged (reengraved after Insect Life, Division of Entomology).

wings fully expanded it measures nearly an inch and is of a purplish brown color, with darker and paler bands, as shown in figure 34, *a*.

The pale-yellow eggs are laid singly or in rows of two to five or more, overlapping like scales. The young webworms are whitish, with polished black head and piliferous spots. Mature caterpillars (*b*) are darker than the garden webworm, with a preponderance in longitudinal markings.

It is an inhabitant of western and central Europe and northern Asia, and has evidently, like the beet army worm, been introduced from the Orient on the Pacific coast, and is now slowly but steadily pushing its way eastward. In 1869 it came under observation in Utah, and by 1873 had found its way to Missouri. It occurs southward to Kansas and as far north and east as Michigan, but the major portion of reported injuries have occurred in Kansas and Nebraska.

Practically all that is known of the biology of this webworm is from

[a] Riley & Howard, Insect Life, Vol. V, pp. 320–322; Vol. VI, pp. 369–373; Chittenden, Bul. 33, new series, pp. 46–49.

data accumulated by the Department of Agriculture. The life history has not been followed throughout, but two generations have been differentiated, and possibly a third is produced in the most southern region which the insect inhabits, the moths from which issue in autumn. Where observed in Nebraska there was a short-lived July generation, requiring only two weeks between the maturity of the caterpillars and the appearance of the moths, which coupled and deposited eggs for another generation. The caterpillars of the July brood transform to pupæ almost immediately after entering the ground, but the last generation remains as larvæ for some time before assuming the chrysalis stage. A wild food plant, pigweed or careless weed (Amaranthus), has been observed, and it has been noticed also that injury to fields of sugar beet are most observable where the ground had been allowed to run to this wild plant. In Europe it lives on another pigweed (Artemisia). A parasitic enemy of this species is illustrated in figure 35.

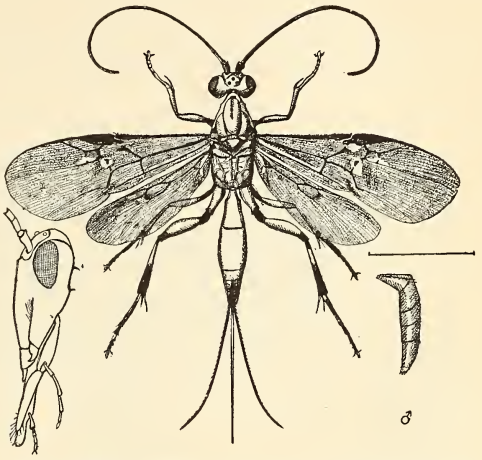

FIG. 35.—*Agathis* (*Cremnops*) *vulgaris:* female, head at left; abdomen of male, side view, at right—enlarged (redrawn after Insect Life, Division of Entomology).

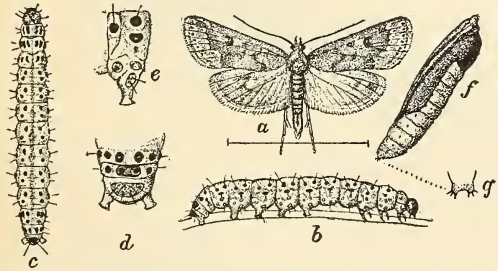

FIG. 36.—*Loxostege similalis: a*, male moth; *b*, larva, lateral view; *c*, larva, dorsal view; *d*, anal segment; *e*, abdominal segment, lateral view; *f*, pupa; *g*, cremaster—*a*, *b*, *c*, *f*, somewhat enlarged; *d*, *e*, *g*, more enlarged (reengraved after Riley, except *c*, original, Division of Entomology).

THE GARDEN WEBWORM.

(*Loxostege similalis* Gn.)

The garden webworm has the same natural food plant (Amaranthus) as the sugar-beet species, but is native to America, and although widely distributed is somewhat restricted as regards important injuries to the South and Middle West, particularly in States between the Mississippi Valley and the Rocky Mountain region. In 1885 it was the cause of serious trouble over a large area, including five States and Indian Territory.[a] It is a general feeder, and attacks most vegetables, cereals, grasses and other forage crops, as also tobacco

[a] Rept. Comm. Agr. for 1885 (1886), pp. 265–270.

and sugar-cane, but its injuries are most pronounced on corn and cotton. The moth (fig. 36, *a*) is variable from yellow to buff, and there is variation in the degree of markings of the fore-wings. The expanse is about three-fourths of an inch. The larva (*b*, *c*) is also variable, the ground colors running through pale and greenish yellow to dark yellow. It seems probable that, as two generations have been observed in the Middle States and three in the South, the life history of this species is not materially different from that of the beet webworm. Eggs are deposited on lower surfaces of leaves, and the caterpillar, soon after hatching, draws together the edges of a leaf by means of its web, or fastens together two contiguous leaves, forming a shelter, from which it crawls forth to feed. A parasite of this species is shown in figure 37.

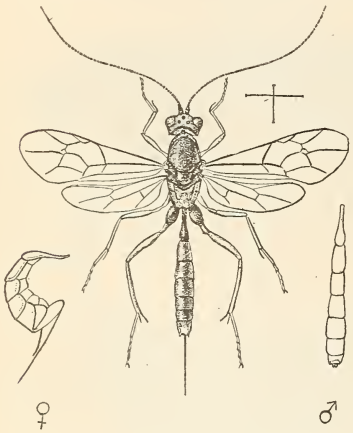

FIG. 37.—*Limneria curycreontis:* adult female; ♀, abdomen of female, lateral view; ♂, abdomen of male, dorsal view (after Insect Life, Division of Entomology).

Remedies.—Paris green applied as a spray has been used with perfect satisfaction against both of these webworms, the fact that they are more or less surrounded by webs and leaf tissues offering little or no barrier to the effects of the poison. In addition, clean cultural methods, including late plowing in the fall followed by deep plowing in spring, and the burning of all waste material and weeds, are of service in controlling these pests. Early planting is also useful as a safeguard for some crops.

MISCELLANEOUS CATERPILLARS.

In addition to the caterpillars which have been mentioned—cutworms, army worms, and webworms—a number of other forms of different classes and with varying habits are so frequently found in beet fields as to deserve consideration. The first two that will be mentioned are naked caterpillars; the last two are hairy caterpillars, or woolly bears, as they are familiarly termed.

THE WHITE-LINED MORNING SPHINX.

(*Deilephila lineata* Fab.)

An illustration and short account of this species, known also as the purslane sphinx, is presented, because it is frequently found in beet fields and evinces an apparent preference for beet among cultivated plants. From its very large size it might be judged a pest of importance. On the contrary, it feeds naturally on purslane, seeming to

injure beets only when the former plant is exhausted or unavailable. Occasionally it occurs in some numbers, as has happened in several localities in the past three years, and then may attack various other useful plants, among which turnip, watermelon, buckwheat, grape, and the leaves of apple have been recorded. During 1900 Mr. Edward C. Post reported injury to sugar beets at Dundee, Mich., and Mr. T. Lytle, Manzanola, Colo., reported damage to tomatoes and to apple and prune trees.

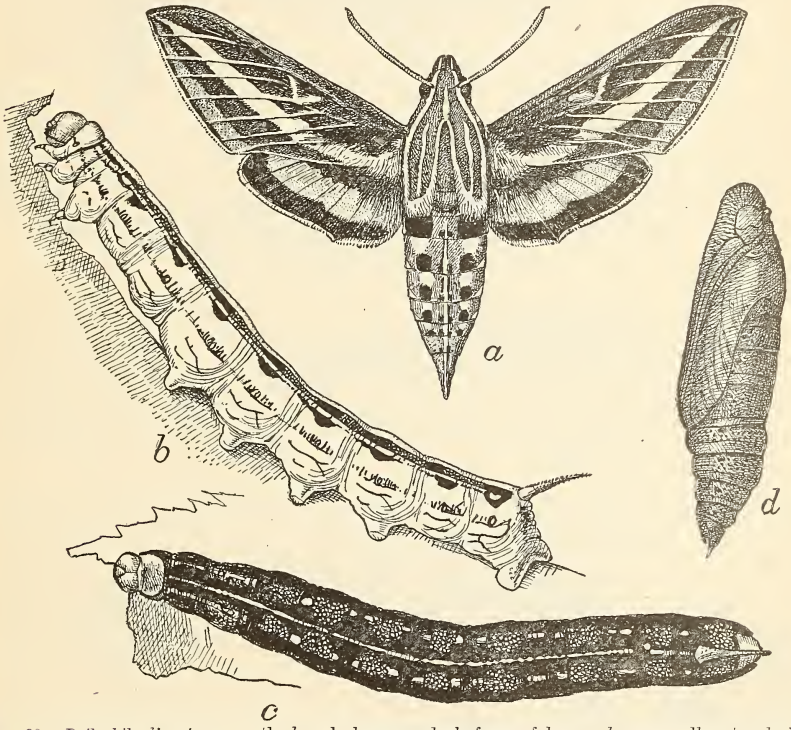

FIG. 38.—*Deilephila lineata: a*, moth; *b*, pale larva; *c*, dark form of larva; *d*, pupa—all natural size (original, Division of Entomology).

The resemblance of the adult (fig. 38, *a*) to a humming bird is marked particularly when the insect is in flight. It will be noted that there are two forms of the caterpillar, a light one (*b*) and a dark one (*c*). The insect belongs to the same group as the more familiar tomato and tobacco worms, and its life habits are somewhat similar.

Remedies.—On account of the large size of this insect it is not difficult to control it by picking the young caterpillars from the plants and destroying them. They also succumb to the arsenicals.

THE ZEBRA CATERPILLAR.

(*Mamestra picta* Harr.)

The zebra caterpillar is a conspicuous garden pest, particularly attached to vegetables, showing some preference for beets and spinach,

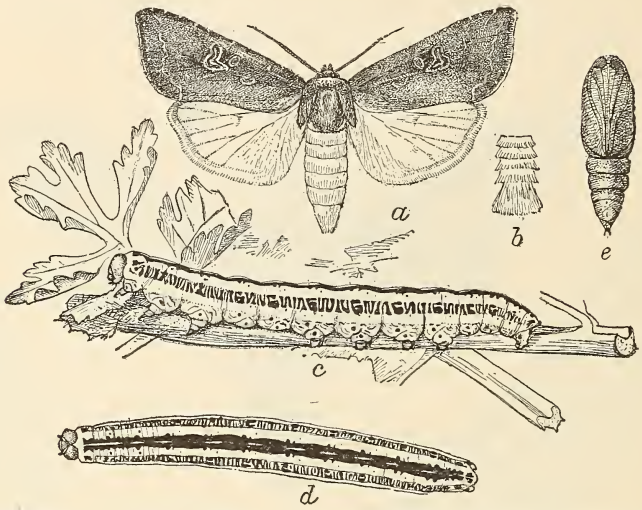

FIG. 39.—*Mamestra picta: a*, female moth; *b*, abdominal segments of male moth; *c*, pale form of larva, lateral view; *d*, larva, dorsal view; *e*, pupa—all somewhat enlarged (original, Division of Entomology).

cabbage, celery, peas, and asparagus, and feeding at times on nearly all forms of vegetation, including cereals, weeds, and the foliage of trees. As previously mentioned, it bears the distinction of being the first insect reported to affect beets in this country. The moth (fig. 39, *a*) resembles in general contour the progenitors of cutworms belonging to the same group of insects. It has a wing expanse of about an inch and a half; the fore-wings and thorax are brown, shaded with darker purplish brown, and the hind-wings are white, tipped with pale brown at the margins. The larva or caterpillar (fig. 39, *c*, *d*) is somewhat variable, but the head is red and the ground color yellow, more or less strongly marked with black, the stripes on the sides suggesting the name of zebra caterpillar. The larva when first hatched from the egg is dull gray and looks quite unlike the mature form. Two views of the newly hatched larva are presented in figure 40, *a*, *b*, while the third stage is shown at *c*.

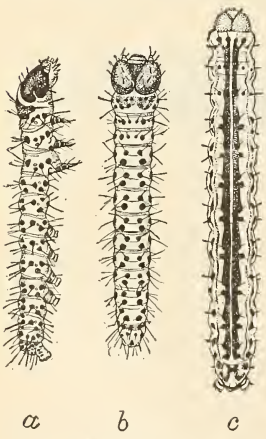

FIG. 40.—*Mamestra picta: a*, *b*, newly hatched larva; *c*, larva of third stage—much enlarged (original, Division of Entomology).

This species is quite abundant in the North, becoming most trouble-

some in the second generation, which usually appears in September. In addition to the plants that have been mentioned as furnishing food for the zebra caterpillar are cauliflower, turnip, beans, carrot, potato, corn, currant, cranberry, willow, roses, and others. The winter is passed in the pupal condition, and the moths appear in May and June. The first eggs hatch in a moderate temperature in six days, and the larval period is about five weeks. The pupal period is very long, lasting, as observed by the writer, sixty-seven days, making in all a period of one hundred and ten days from the time the eggs were laid until the moths appeared, late in August. This species can endure a considerable amount of cold, but is very susceptible to parasitic attack, and to a less extent to fungous diseases.

Methods of control.—The caterpillars when first hatched are gregarious, hence easily discovered at this time and destroyed by hand or by poisons. They yield readily to sprays of arsenicals, but these are not necessary in ordinary cases of attack.

THE SALT-MARSH CATERPILLAR.

(*Leucarctia acræa* Dru.)

Several forms of hairy caterpillars, such as the yellow bear (*Spilosoma virginica*), of similar appearance and habits, are commonly found on sugar beet. One of these, known as the salt-marsh caterpillar

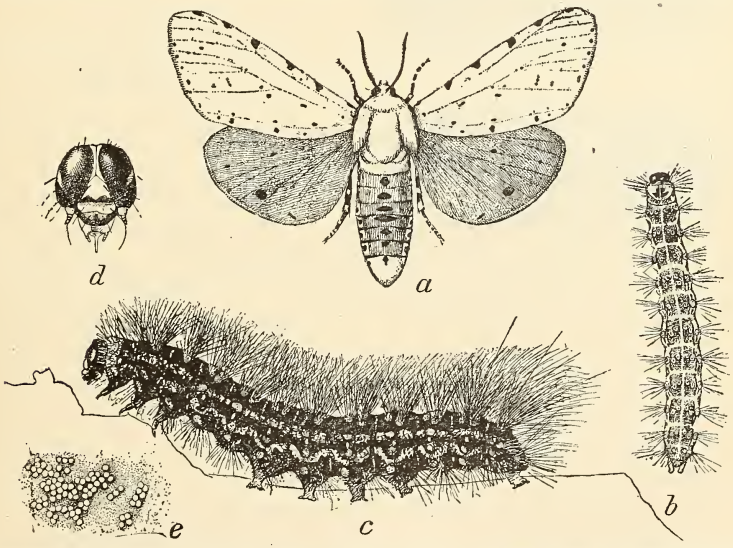

FIG. 41.—*Leucarctia acræa: a*, female moth; *b*, half-grown larva; *c*, mature larva, lateral view; *d*, head of same, front view; *e*, egg mass—all slightly enlarged except *d*, more enlarged (original, Division of Entomology).

(*Leucarctia acræa* Dru.), from its ravages early in the past century upon forage crops grown in the salt marshes of New England, is occasionally troublesome in beet and corn fields and in gardens.

This caterpillar differs from the common yellow bear in having a darker body, and the sides are distinctly ornamented with yellow markings. The two species are of about the same length, and the hairs present a similar variation in color. A young larva is illustrated at figure 41, *b*, a mature one at *c*. The moths also closely resemble each other, but the fore-wings of the present species are strongly marked with black, and the abdomen, with exception of the first and last segments, is bright ocher above, with black markings. In the female the hind-wings are white, like the fore-wings, and similarly marked with black, but in the male they are ocher with two black dots (fig. 41, *a*). The life economy of these species is very similar; they form the same sorts of cocoons and transform in any convenient place where shelter can be obtained. In New England the salt-marsh caterpillar is credited with having a single generation, but a little farther south, in the Middle States, two generations have been recognized.

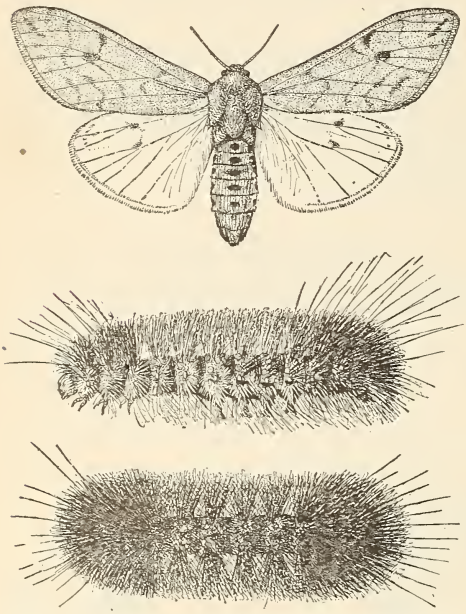

FIG. 42.—*Isia isabella:* male moth above; caterpillar, side view, in middle; dorsal view at bottom—somewhat enlarged (original, Division of Entomology).

THE HEDGEHOG CATERPILLAR.

(*Isia* [*Pyrrharctia*] *isabella* S. & A.)

Another conspicuous caterpillar known to attack beets is shown in the accompanying illustration (fig. 42). It is recorded also as affecting peas and corn, but appears to prefer plantain and other weeds, such as dandelion and burdock. The general color of this caterpillar is bright cinnamon red and usually each end is black. The long hairs with which the body is covered are so evenly distributed as to give it the appearance of being shorn or cropped. The name of hedgehog caterpillar is derived from the habit of this insect of rolling up when disturbed and of passing the winter under the bark of trees or in some similar location rolled up like a hedgehog. The life history of this insect is very similar to that of the preceding. The moth (fig. 42) is dull orange, with the fore-wings marked with dusky stripes, both the fore and hind-wings being spotted with black, the latter a little paler than the others.

Remedies.—As a rule neither this insect nor the salt-marsh caterpillar occurs in troublesome numbers; hence remedies are not often necessary. It can be controlled by ordinary methods of spraying and hand picking.

GRASSHOPPERS, CRICKETS, AND RELATED INSECTS.

Of great economic importance in the West, and in some seasons in other regions, are numerous species of locusts, popularly termed grasshoppers. Several forms of related insects, such as katydids and crickets, are also injurious, but all of these insects are general feeders, and as a rule destructive to sugar beets and other vegetable crops only in seasons which have been particularly favorable to their multiplication, and their operations are mainly confined to fields adjacent to grass lands. The numbers of these insects mount into the hundreds, but the really important species might be reduced to between twenty and thirty. Fourteen are listed as sugar-beet pests.

For present purposes it will be necessary to mention specifically only a few of the most abundant of the grasshoppers. Like most other forms of the order Orthoptera, they are mostly large insects, with mouth parts formed for biting, and with incomplete metamorphoses, the young more or less closely resembling the adults, save for the lack of wings. Their name is sufficient indication of their habits: They live normally on grasses for the most part, and their thighs are large, fitting them for long leaps. Everyone knows them so well that further description is unnecessary. Some species are capable of extended flight for hundreds of miles, with occasional intermissions daily for food. In their migrations they go in swarms, and sometimes darken the face of the sun, or at night of the moon.

Grasshoppers may be classified, as regards their habits, as nonmigratory and migratory. The former breed and pass their entire lives in or near the place where the eggs were laid. The migratory species breed in enormous numbers, and when they become too abundant for the limited food supply of a region, they develop the migrating habit and travel in swarms. These insects are particularly abundant and troublesome in arid and semidesert regions, and as their numbers are subject to great variation according to climatic and other conditions, the visitation of a locust swarm may be expected at any time during the warmer months of the year. In dry regions locusts are the most dreaded of insect pests. Because of their voracity and the rapidity of their attack, they lay waste entire townships, counties, and even large portions of States.

THE RED-LEGGED LOCUST.

(*Melanoplus femur-rubrum* De G.).

This is our commonest North American grasshopper, being found practically everywhere. It is one of the smaller species (fig. 43), and where it is not held in subjection by numerous natural enemies of various kinds it may become a decided nuisance in cultivated lands. It was destructive to sugar beet in Illinois in 1899. It seldom exhibits the migratory tendency, but sometimes gathers in swarms and moves in concert, not, however, rising to great heights, but drifting with the wind as do the true migratory species.

FIG. 43.—*Melanoplus femur-rubrum*—natural size (after Riley).

THE ROCKY MOUNTAIN LOCUST.

(*Melanoplus spretus* Thomas).

This is the most destructive of all native grasshoppers, and has been the cause of greater losses to agriculture in the past thirty years or more than perhaps all of the other known species of grasshoppers combined. Its range of injuriousness is not limited to the Rocky Mountain region, but it is more abundant there than elsewhere. It is illustrated in figures 44 and 45.

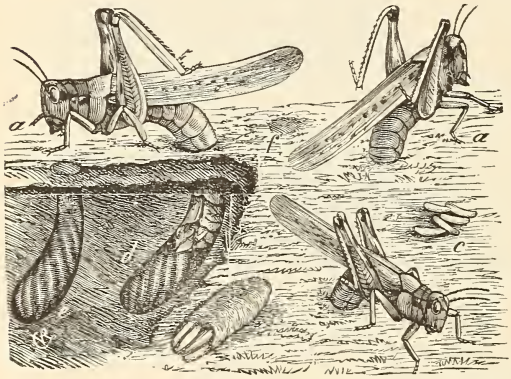

FIG. 44.—*Melanoplus spretus: a, a, a*, female in different positions, ovipositing; *b*, egg-pod extracted from ground, with the end broken open; *c*, a few eggs lying loose on the ground; *d, e*, show the earth partially removed, to illustrate an egg-mass already in place and one being placed; *f*, shows where such a mass has been covered up (after Riley).

Those who were interested in farming in the 70's in Kansas, Nebraska, and some neighboring States have cause to remember the depredations of the Rocky Mountain locust. During 1874–1877 it was directly responsible for the loss of $100,000,000, in addition to an indirect loss by the stoppage of business and other enterprises which might have aggregated as much more. It was for an investigation of this species that the

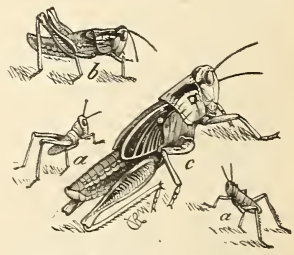

FIG. 45.—*Melanoplus spretus: a, a*, newly hatched nymph; *b*, full-grown nymph; *c*, pupa, natural size (after Riley).

United States Entomological Commission was formed, which published from 1877 to 1879 two voluminous reports on it alone. A shorter account of this and some of the other more important grasshoppers discussed in the Commission Reports is furnished in Bulletin No. 25 (o. s.), Division of Entomology.

THE DIFFERENTIAL LOCUST.

(*Melanoplus differentialis* Thomas.)

In Kansas and Nebraska and elsewhere in the Middle West the farmer is much bothered at times by the large yellow locust, shown in figure 46. It can usually be found along roadsides and on the edges of groves, preferring rank vegetation where such abounds. When it becomes unusually numerous it is quite destructive to vegetable crops and to cereals; in fact, it is rated by some as next in importance to the two species which have been considered. Two forms of this insect make their home in the Middle West—a yellow form, which is the commonest, and a black one. They do not appear to differ otherwise than in color.

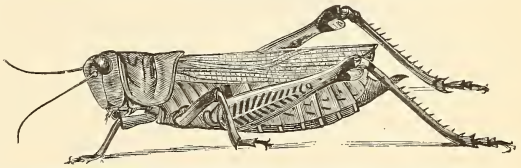

FIG. 46.—*Melanoplus differentialis*, natural size (after Riley).

THE TWO-STRIPED LOCUST.

(*Melanoplus bivittatus* Say.)

The name two-striped locust and the accompanying illustration (fig. 47) together with the statement that the ground color of this species is brown, striped with yellow, is sufficient for its determination. It is somewhat variable, however. Like others of its kind it develops where vegetation is rank, in weed patches and in low ground, and after exhausting the vegetation in such localities it enters gardens and cornfields and does much injury to crops. It occurs from the Atlantic to the Pacific, and from the Gulf States to far North.

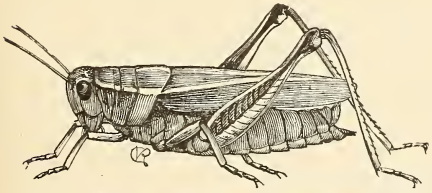

FIG. 47.—*Melanoplus bivittatus*, natural size (after Riley).

METHODS OF CONTROL.

Grasshoppers are generally kept within normal numbers by numerous natural agencies, among which are nearly all large forms of insectivorous birds and mammals, batrachians and reptiles, and fungous diseases. They also have large numbers of predaceous and parasitic

insect enemies, which kill them off in ordinary seasons. With changes of atmospheric conditions, however, the insect and fungous enemies are frequently destroyed, and then the grasshoppers increase in abundance. In such cases they can be destroyed by several artificial methods. The remedies that have proved most efficient are: (1) plowing under the eggs before these have had time to hatch, and

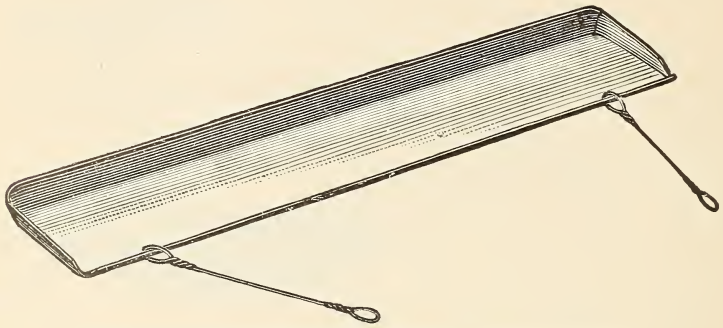

FIG. 48.—A simple coal-tar pan to be drawn by hand (after Riley).

(2) capturing the unfledged locusts, as well as many of those which have become winged, by means of hopperdozers or kerosene pans.

Hopperdozers are necessary implements of warfare against most grasshoppers. They are shallow sheet-iron pans, made of any size most convenient, or canvas frames, mounted on runners to be drawn over the ground either by a horse or by hand, preferably against the wind, in such a manner that the grasshoppers will leap into them and be killed by coming into contact with the tar or oil which is poured into them for the purpose. Two forms of hopperdozers are shown in figures 48 and 49.

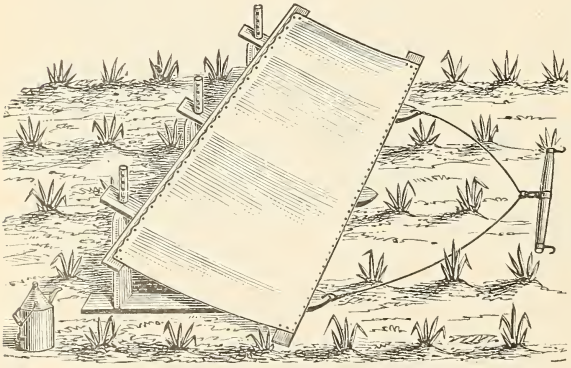

FIG. 49.—A canvas hopperdozer to be drawn by horse (after Riley).

Bran-arsenic mixture is another remedy of great value in the prevention of injury to our cultivated crops. The directions for preparing this mash have been given under remedies for cutworms (page 185).

Fungous diseases as a remedy.—During the years 1901–2 the subject of the possible control of grasshoppers by means of contagious diseases was taken up by the Division of Entomology, and a report by Dr.

Howard of progress in experimental work was published in the Yearbook of the Department for 1901 (pp. 459–470). Unfortunately the spread of these diseases is so contingent upon certain weather conditions that while uninfected grasshoppers may be inoculated under the most favorable circumstances, we can not always obtain or predict atmospheric conditions which will operate with the disease in destroying the grasshoppers. The conclusion is therefore reached that, owing to the inability of man to control the conditions necessary to the spreading of the disease, it is far better to employ the bran-arsenic mash, hopperdozers, fall plowing, and other remedies which have been specified where possible in preference to the fungus; in other words, we can not depend absolutely on the fungus, although in some cases it is eminently beneficial, more especially in climates which are unusually moist and in which the conditions desired are ordinarily present. The principal diseases in question are caused by *Mucor ramosus*, *Empusa grylli*, and an undetermined species of the genus Sporotrichum.

Poisoned horse droppings.—During recent years Mr. Norman Criddle has used a mixture with great success against locusts in Manitoba. It consists of 1 part of Paris green mixed thoroughly in 60 parts of fresh horse droppings, 2 pounds of salt to half a barrel of mixture being added after being dissolved in water. This is placed in a half barrel and drawn on a cart to the edge of the infested field or one likely to be invaded. The mixture is then scattered broadcast along the edge of the crop, or wherever needed, by means of a trowel or wooden paddle. The locusts are attracted to it and are killed in large numbers by eating the poison.[a] Although this mixture is "sure death," it sometimes requires from two to five days for it to kill the locusts.

Rye as a trap crop.—Manitoba farmers also deal successfully with locusts by sowing a strip of rye around the edge of a field of wheat. The former grain grows more rapidly and it requires a long time for the insects to eat sufficiently of it to destroy it. The rye is poisoned with a spray of Paris green. Beet fields might be protected in the same manner.

Burning over and plowing.—In some cases it has been possible to ascertain the particular breeding places of grasshoppers, some species depositing their eggs in pasture lands and among foothills at the bases of mountains in the far West in regions in which the tar weed grows. Here the egg cases can be destroyed by burning over the ground late in the fall after all of the eggs are deposited, or by plowing them in to a depth of 6 or 8 inches before they hatch in the spring.

In case, for any reason, it is not feasible to employ any of these last-mentioned remedies, and the place of egg deposit is ascertained, a watch should be kept for the young grasshoppers and they should be

[a] Fletcher, Rept. Ent. and Bot. Experimental Farms, Canada, for 1902, 1903, p. 187.

destroyed as soon as possible after hatching by means of the bran-arsenic mash.

Turkeys.—Prof. Lawrence Bruner, of Nebraska, states that turkeys are useful in freeing orchards and vineyards of grasshoppers and they may be employed in other fields for the same purpose. In one case a flock of 766 turkeys was kept at work in the destruction of grasshoppers. The turkeys have to be watched, however, as they sometimes vary their diet with vegetables.

Cooperation is of the greatest value in the treatment of grasshoppers, particularly in regions where they reach their greatest development; and the thoroughness with which work is done in one year will show in the greatly reduced numbers with which the farmers will have to deal the next season.

Many of the remedies that have been advised as remedies for grasshoppers in general are applicable to the migratory forms, but these frequently occur in such immense swarms that it is practically impossible to check them until the crops are destroyed. It is of the highest importance, therefore, that remedies be employed at the very first onset, and that these measures be generally observed over considerable territory, as the insects fly rapidly from one field to another.

LEAF-MINERS.

Three forms of maggots, the young of small two-winged flies, more or less resembling the common house fly, mine the leaves of beets and spinach, causing variable blotches on the outer cuticle, which is left entire until ruptured by the escape of the maggot when it matures and deserts its old home for transformation in the earth below. The abandoned mines dry, shrivel, and become torn by subsequent growth of the plant.

THE BEET OR SPINACH LEAF-MINER.

(*Pegomya vicina* Lintn.).[a]

The beet or spinach leaf-miner is the best known of these insects, and at the present time the only one that need be considered. It is practically confined to beets, spinach, and like plants, such as lambsquarters, and is to be reckoned among prominent beet pests, as it is apparently increasing in destructiveness.

The parent fly is shown at figure 50, *a*, *b* representing the head of the male, and *c* that of the female. The ground color is gray with the front of the head silver white. The body, including the legs, is rather

[a] Lintner, 1st Annual Rept. Insects N. Y. for 1881 (1882), pp. 203–211; Howard, Insect Life, Vol. VII, pp. 379–381; Sirrine, 14th Rept. N. Y. Agricultural Experiment Station for 1895 (1896), pp. 625–633; Pettit, Bul. 175, Mich. State Agr. College Exp. ta., 1899, pp. 356–357.

sparsely covered with long stiff black hairs. When in action the body is carried usually in a somewhat curved position, but when extended measures nearly a quarter of an inch. The maggot (*f*) is white, and so nearly transparent that the contents of the abdomen can be seen through the posterior portion.

In many cases infestation can be traced directly to the insects having bred in lambs-quarters and similar weeds, which if not destroyed by ordinary methods of cultivation mature and die during October. The flies, by close observation, may be seen in flight just above the ground or hovering about their different food plants. The eggs are placed on the lower surface of the leaves and arranged in masses of from two to five. When the young hatch they bury themselves

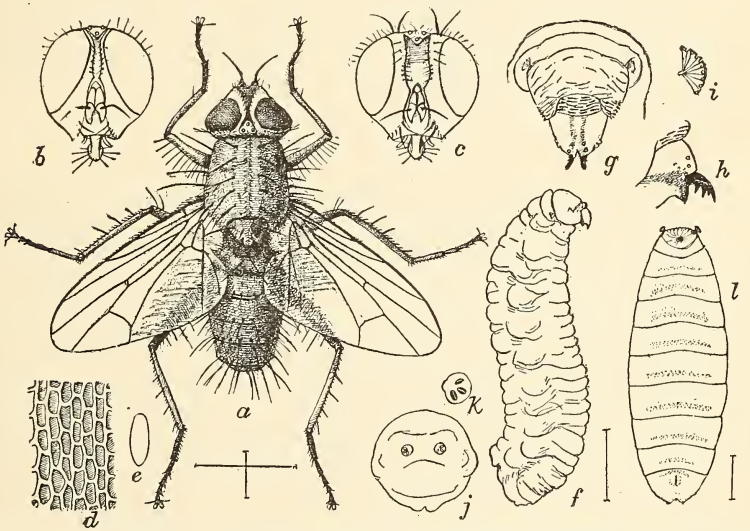

FIG. 50.—*Pegomya vicina: a*, fly; *b*, head of male fly; *c*, head of female; *d*, surface of egg, highly magnified; *e*, egg; *f*, maggot; *g*, head of same; *h*, cephalic hooks of maggot; *i*, prothoracic spiracles; *j*, anal segment; *k*, anal spiracles; *l*, puparium—all enlarged (after Howard, Division of Entomology).

within the leaf tissue, constructing a thread-like mine which they afterwards extend in a curve or semicircle.

Transformation to pupæ takes place in most cases in loose soil, which the maggots enter only to a short distance or under fallen leaves. Occasionally maggots transform within a leaf if the latter happens to rest on the ground.

Injury appears to be most frequent in late fall, but may be due to earlier generations in midsummer. Dr. Howard states that eggs hatch in from three to four days, and the larval stage is passed in seven or eight days, the puparium or resting stage requiring from ten to twenty days. These periods will vary according to the state of the atmosphere. An instance of damage to spinach in Pennsylvania was reported in May, 1903.

Methods of control.—When this leaf-miner occurs in kitchen gardens it is most easily controlled by gathering and destroying the leaves as soon as found infested, and neighboring plants which serve it for food should be treated in the same manner. In large fields of sugar beet much injury might be averted by proceeding in the same manner at the outset of attack.

Insecticides have been suggested, but the habit of the maggot of feeding within the leaf at once indicates their uselessness. Kerosene emulsion has been tried without effect. Mr. Sirrine has observed that many gardeners and farmers on Long Island, where this insect is a spinach pest of importance, have practiced late fall and early spring plowing, and are still troubled with it. But it is probable that clean culture is not also practiced, hence the insects have an opportunity to breed in weeds and return to cultivated plants. As the insect appears to prefer spinach to beets, it is possible that the former might be used as a trap crop in sugar-beet fields.

PLANT-BUGS.

The sugar beet furnishes sustenance for hordes of sucking insects, such as plant-bugs, plant-lice, leaf-hoppers, root-lice, and numerous related forms, but many of these insects live normally on wild plants, weeds, and grasses, on which their younger stages are passed, and prefer most other vegetable crops, when readily obtainable, to beets. Among the more common forms of these insects which obtain nourishment by suction are several species of true bugs of the family Capsidæ, generally termed plant-bugs, although some forms are also known as leaf-bugs, chinch bugs, and by similar names indicative of their habits or appearance. The commonest and most injurious of these insects are two forms of false chinch bugs and the tarnished plant-bug and garden flea-hopper.

THE TARNISHED PLANT-BUG.

(*Lygus pratensis* Linn.)

As this is the commonest of all bugs, and, according to general verdict, one of the most troublesome, it may serve as an example of this class. It is at home practically everywhere in North America, from Canada to Mexico, and attacks most plants whether cultivated or wild. It occurs in fields of sugar beet throughout the warm season, and frequently does damage to garden crops, both vegetable and fruit, and to trees grown in nurseries.

The mature plant-bug is of the appearance shown in figure 51 at the left. The general color is a pale, obscure, grayish brown, marked with black and yellow, the thorax also with red. The pattern is variable, but more or less as illustrated. The legs are still paler brown or yellow-

ish, ringed with darker brown. The length is about one-fifth or three-sixteenths of an inch.

This plant-bug has been stated to pass through four stages of growth from the time it hatches from the egg until it reaches the adult condition, but there is little doubt that there are five stages, to agree with other species of plant-bugs which have been traced through their metamorphoses. In the first stage the insect measures only one-twentieth of an inch, and is yellowish or yellowish green in color. The known stages are shown in figures 51 and 52.

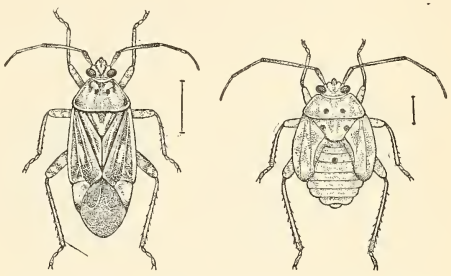

FIG. 51.—*Lygus pratensis:* adult bug at left; last stage of nymph at right—nearly four times natural size (original, Division of Entomology).

Were it not for the fact that this plant-bug feeds upon such a variety of crops as well as weeds, thus diminishing the damage, it would be much more injurious than it really is. It has been asserted, and with probable truth, that the puncture of the bugs is poisonous to plant life.

The bugs are extremely active, and quick of flight as well as on foot, and when disturbed in the least have the habit, in common with many other plant-bugs, of dodging to opposite sides of the plant, where they remain out of sight.

The tarnished plant-bug, as previously stated, can be found afield throughout the season, appearing in early spring and disappearing only when cold weather approaches. Hibernation is usually in the adult stage, but the nymphs or immature forms are sometimes seen under circumstances that would lead to the belief that the species also winters over in this stage. The insects pass the winter under any convenient shelter, particularly in rubbish left in fields and in fence corners, and under leaves, boards, and stones. After copulation in early spring the females deposit their eggs singly and directly on their host plants, oviposition continuing for two weeks or longer.

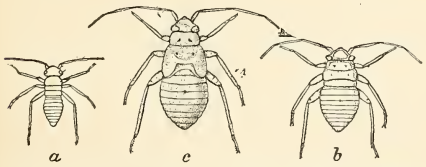

FIG. 52.—*Lygus pratensis: a*, newly hatched nymph; *b*, nymph of a later stage; *c*, fourth stage—three or four times natural size (after Forbes, Division of Entomology).

Remedies.—The great activity of the tarnished plant-bug, coupled with its habit of feeding on so great a variety of plants, passing from one to another with no apparent choice, renders it more difficult of control than if it were concentrated. It can not be kept in bounds by any single remedy, at least when it occurs in great numbers. In the application of insecticides, or other remedial measures, it is necessary

to include other food plants or most forms of vegetation in order to keep the insects away from the crop which is being injured.

Kerosene emulsion is one of the best remedies, but must be applied thoroughly and at frequent intervals.

Pyrethrum must be applied in the same manner, but as it is one of the most expensive of insecticides its use would hardly be profitable on beets, although valuable on some other plants subject to injury, for example, on berries, where it is impossible to apply poisons that would be harmful to man.

If insecticides are employed they are best applied early in the morning, before the insects have become thoroughly active and while the dew is on the plants, as this facilitates the spreading of most applications which are used.

Hand methods, although scarcely applicable to large fields, are of the greatest value over small areas, and a hand net of stout cloth is useful for sweeping plants and surrounding grasses and weedy vegetation in which the insect is sure to be found. A day's experience will be sufficient to teach anyone that more insects can be captured in this manner than in any other.

Clean culture, although mentioned last, is the first necessity, and if fields subject to injury by this plant-bug are kept free from weeds of all kinds and the rubbish is cleaned away as soon as the crop is harvested, losses will be greatly lessened. After a crop is off "burning over" or "back firing" should be practiced in the same manner as already described in connection with army worms and cutworms.

THE FALSE CHINCH BUG.

(*Nysius angustatus* Uhl.)

This plant-bug is a beet feeder of long standing, and like many other species which have been mentioned, shows a tendency toward being omnivorous, although cruciferous plants, such as cabbage and turnip, appear to be the favorite food. It does more or less injury to potato, lettuce, grapevine, strawberry, and even grass and the foliage of apple trees. Its English cognomen is derived from the fact that since very early times it has been sent by correspondents to official entomologists under the impression that it was the true chinch bug, to which, indeed, it is related.

It is grayish brown and of the appearance shown at figure 53, *c*, measuring about one-eighth of an inch. In the same figure, at *a*, a leaf of potato is illustrated, which shows minute circular specks which are rusty in color where the beak of the bug has been inserted. This recalls the method of attack of certain flea-beetles which have already been described. When occurring in large numbers the false chinch bugs crowd together on plants after the manner of chinch bugs on corn,

and harlequin bugs on cabbage, and as they feed by suction they soon exhaust a plant by depriving it of its vital juices, causing it in time to wilt and perish. The distribution of the species extends from New Hampshire to the Gulf, and westward to the Pacific States. It is subject to the same atmospheric influences as the true chinch bug, damp, rainy weather being unfavorable to its development.

Remedies.—The best manner of holding this bug in control consists in clean culture, keeping down all purslane, a favorite host plant, the careful cleaning up of crop remnants and other trash before winter, and the collection of the bugs when they occur in numbers in pans or pails filled with water and a thin scum of kerosene. The free use of kerosene emulsion and pyrethrum is also of value, the latter, though expensive, being efficient in small fields.

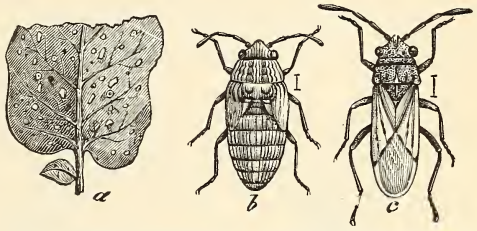

FIG. 53.—*Nysius angustatus: a*, part of small leaf of potato, showing punctures of the bug; *b*, last stage of nymph; *c*, adult—*a*, natural size; *b*, *c*, much enlarged (after Riley, Division of Entomology).

THE MINUTE FALSE CHINCH BUG.

(*Nysius minutus* Uhl.)

According to recent reports emanating from several sources in Colorado, this insect is of growing importance as a beet pest. It appears to be more particularly destructive to beets grown for seed, the injury being accomplished by the bugs sapping the green seed, which in consequence dries up and fails to mature properly.

It differs but slightly from the previously mentioned species, being a little smaller, measuring only about a sixteenth of an inch in length. Its distribution and its food habits appear to be practically the same, in fact additional study is necessary to determine whether the two forms are actually distinct species.

Remedies.—It has been ascertained by beet growers that the flooding of infested fields causes the insects to leave, and the growing of mustard as a trap crop has given excellent results, precautions being taken that the mustard be not allowed to run to seed, as it is likely to become a pest itself. Other remedies advised for the common false chinch bug just considered are also applicable.

THE GARDEN FLEA-HOPPER.

(*Halticus uhleri* Giard.)

In recent years this minute black bug has been the occasion of considerable injury in various parts of the country. In 1890 it did damage to beans in Kansas, and in 1896 like injury was inflicted on red clover and other plants in Ohio. It is commonly seen in beet fields,

but evinces a partiality for leguminous plants, including cowpea and pea, and has also been destructive to smilax in greenhouses and to potato, morning-glory, and chrysanthemum. In 1897 it was somewhat troublesome on edible legumes in Maryland. Among other plants which it attacks are egg-plant, pumpkin, cabbage, and numerous weeds. It occurs most abundantly on the under side of leaves, which it punctures so as to cause the death of the tissue in small, irregular, somewhat characteristic white patches.

This species is shown highly magnified in fig. 54 in the three forms of its adult stage. In its brachypterous or short-winged form it greatly resembles the common black cucumber flea-beetle, alike in appearance, in the nature of its work, and in its saltatory power. It is evidently native and well distributed from Canada and New England southward to Florida and westward to Utah. This shows a range

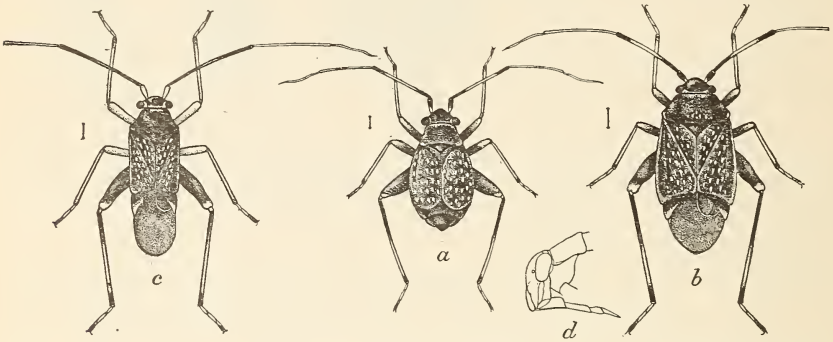

FIG. 54.—*Halticus uhleri: a*, brachypterous female; *b*, full-winged female; *c*, male; *d*, head of male in outline—*a*, *b*, *c*, much enlarged; *d*, more enlarged (author's illustration, Division of Entomology).

from the Boreal life zone to the Gulf strip of the Lower Austral. According to the observations of Mr. F. M. Webster, this species may hibernate in the adult stage, although probably it usually passes the winter in the egg.

Remedies.—The best remedy is kerosene emulsion applied thoroughly as an underspray.

Many of the instances of injury that have been reported have been largely due to the planting of susceptible crops in the immediate vicinity of clover, which is evidently the preferred host plant. When the clover is cut the flea-hoppers migrate to other crops, and when sufficiently numerous cause damage. It is obvious that with a little care in cropping, such as the avoidance of growing crops subject to injury in the immediate vicinity of clover, much injury would be averted.

LEAF-HOPPERS.

Numerous species of leaf-hoppers, insects which obtain their food by suction in the same manner as plant-lice, are nearly always to be found on sugar beet and similar vegetables. None of these, however, appears to be restricted to vegetables for food, but usually develop on grasses, although occasionally also on other plants. As a rule, in their earlier stages they exhibit a decided limitation to the food plant on which they began breeding; but as they near the more mature stages they assume the habit of feeding more indiscriminately. Considerable divergence is exhibited in regard to life histories; but since these insects are, as a rule, not particularly destructive to beets, further discussion of this general problem may be omitted.

THE CURRANT LEAF-HOPPER.

(*Empoasca mali* Le B.)

This leaf-hopper is described by Messrs. Forbes and Hart as "probably our worst all-round leaf-hopper pest, so excessively abundant that notwithstanding its varied diet it is able to make a serious attack on quite a number of the cultivated plants on its list." It has been found in extreme abundance on sugar beet everywhere in Illinois, both as nymph and adult, showing its ability to breed on this plant. It also attacks beans, cowpea, potato, celery, and corn, and various fruits, as well as shade and forest trees. It is a tiny insect, pale green in all stages, and is apt to be confused with related species. The row of six (sometimes eight) white dots along the anterior margin of the prothorax distinguishes it from others.

THE FLAVESCENT LEAF-HOPPER.

(*Empoasca flavescens* Fav.)

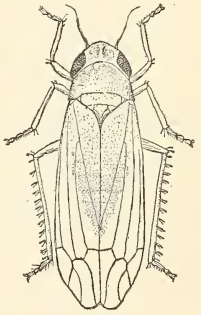

FIG. 55.—*Empoasca flavescens*—highly magnified (original, Division of Entomology).

Very similar to the preceding in appearance, size, habits, and distribution is the above-mentioned species (fig. 55). It is sometimes even more abundant. It is paler, nearly white, and has only three spots on the margin of the thorax.

REMEDIES.

As a result of studies of the life economy of leaf-hoppers, it has been ascertained that simply cutting the grass and perhaps some other plants affected, and leaving it in the field, will prevent eggs from hatching; the drying of the stems results in the crushing and distortion of the eggs, owing to the shrinkage of the plant tissues and the curling of the edges of the sheaths.

PLANT-LICE.

Several forms of plant-lice affect the leaves of sugar beet, but as far as at present known do not inflict extensive injury. Among the plant-lice, however, are some few forms which have the habit of feeding on the roots, being known as root-lice, and these are of the greatest importance when atmospheric conditions conduce to their development or the plants are first injured through other causes.

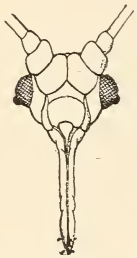

FIG. 56.—Head of plant-louse, showing sucking beak—much enlarged (original, Division of Entomology).

THE MELON PLANT-LOUSE.

(*Aphis gossypii* Glov.)

The melon plant-louse or, as it is more commonly known, the melon louse, is perhaps the commonest species found on beets, and is the best known as well as most destructive of all insects of this class. Fortunately for the beet grower it does not favor this crop, and is usually found only in moderate numbers on beets when other plants are available. The writer has seen a considerable number of this species on beet leaves working in their usual manner by pumping up the juices through their beaks (fig. 56), but although the plants were carefully watched the operations of the plant-lice did not seem to hinder the growth of the plants in any degree. Nevertheless, this louse is capable of serious damage, more especially in the event of exhaustion of favorite host plants, like melons and other cucurbits, which would drive it to beets if these were most available. The principal forms of this insect are illustrated in figure 57.

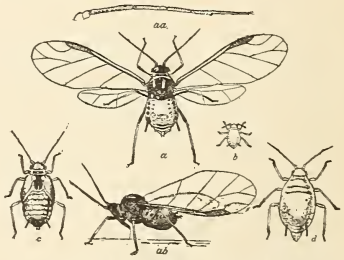

FIG. 57.—*Aphis gossypii: a*, winged female; *aa*, enlarged antenna of same; *ab*, dark female, side view; *b*, young nymph or larva; *c*, last stage of nymph; *d*, wingless female—all greatly enlarged (original, Division of Entomology).

The melon louse is probably of American origin and perhaps tropical, since it prefers plants of a tropical nature, has a very wide distribution in North and South America and the West Indies, and has been observed in Australia. It is therefore apt to be present in most fields of sugar beet, but its occurrence there can usually be traced to other plants on which it develops more freely, some of which have already been mentioned. Among others of the favorite host plants are cotton, okra, purslane, strawberry, and orange and other citrus trees. Attack begins in early spring and may last until winter, according to season, climate, and other circumstances.

Natural enemies.—As an illustration of an insect pest held in abey-

ance and limited to innoxious numbers by natural enemies, no better example could be cited than is afforded by this plant-louse. Its natural enemies include several species of ladybirds or "ladybugs," syrphus flies, aphis lions, the larvæ of lace-wing flies, numerous species of minute hymenopterous parasites, and a parasitic fungus. The insect enemies are most effective in destroying the plant-lice in dry and warm weather. In a cool, damp atmosphere, which is apt to be encountered early in the season when plants are first set out, the insect enemies are as a rule less active, and at such times injury by plant-lice is likely to be most severe.

The species shown in figure 58, known as the convergent ladybird (*Hippodamia convergens*), is one of the most beneficial insects, as it is

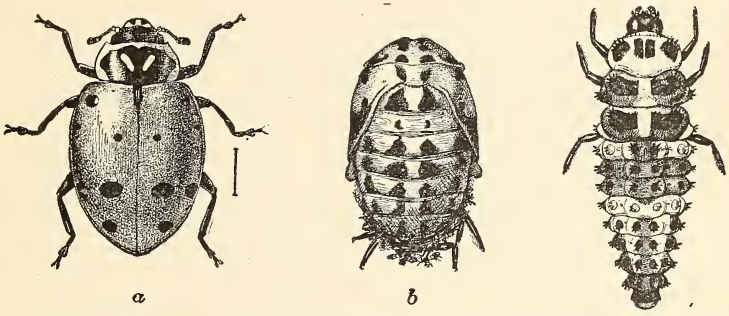

FIG. 58.—*Hippodamia convergens: a*, adult; *b*, pupa; *c*, larva—all much enlarged (original, Division of Entomology).

a most active destroyer of plant-lice which feed on vegetables. It is common on sugar beets, and it is interesting to note that on one occasion it was reported as feeding on the leaves of that plant in Oregon (Bul. 26, o. s., Div. Ent., p. 11).

METHODS OF CONTROL.

The melon louse, although a difficult insect to treat when it occurs on cucurbits and some other plants, can be more readily controlled on beets. In fact, all of the leaf-infesting plant-lice can be destroyed on beets by means of sprays and other washes and by some of the ordinary general methods of farm practice.

Kerosene emulsion.—The standard remedy for plant-lice is kerosene-soap emulsion, made by combining 2 gallons of kerosene, half a pound of whale-oil or fish-oil soap or 1 quart of soft soap, with 1 gallon of water.

In preparing this emulsion the soap is first dissolved in boiling water and then poured while boiling hot, but away from the fire, into the kerosene. The mixture is then churned somewhat violently for about five minutes by means of a force pump and direct discharge

nozzle throwing a strong stream by pumping the liquid back upon itself. When properly combined the mixture will have become of the consistency of thick cream. It is then placed in moderately tight receptacles, and will keep almost indefinitely until required for spraying, when it is to be diluted. For plant-lice this staple emulsion is usually diluted with from 10 to 15 or 20 parts of water.

Its habit of feeding on the lower surfaces of leaves renders the melon louse more difficult to reach by means of a spray than insects which live on the upper surfaces. In the application of an emulsion or other wash, therefore, it is necessary that the hose be fitted with an upturned nozzle in order to secure the under spraying of the leaves, which is the principal resort of plant-lice and many other sucking insects.

It is of the utmost importance that the sprays or other remedies be applied on the first appearance of the insect in order to check it before it succeeds in obtaining a good start and to prevent its further development.

Spraying with water.—A strong stream of water from a hose directed on plants, so as to hit the insects, is of much value in dislodging them from the plants, to which they do not usually succeed in returning, and where this can be readily done more elaborate remedies are unnecessary.

Pyrethrum administered with a powder bellows to the lower sides of leaves is also valuable and particularly effective on young plants. It is, however, expensive, and can not be profitably used in large fields.

Clean culture and fall plowing should be followed as the most effective measure of prevention of attack by plant-lice as well as other insects, and this includes the keeping down of weeds after the main crop has been gathered until the next crop is planted, this treatment serving to rid the fields of many pests, particularly those which do not fly readily, by depriving them of food.

Fumigation methods.—In very recent years two methods of fumigation have been rather extensively practiced as a means of destroying the melon louse and related insects on valuable plants. It is doubtful, however, if either of these remedies would be necessary on beets except in regions where injury is more extensive than has thus far been reported.

If careful watch is kept for the first appearance of this plant louse it can be more thoroughly eradicated by means of fumigation than by any other method. The method of application of bisulphid of carbon consists in covering the affected plants on the first appearance of the pest with a tub or similar receptacle, and evaporating the chemical beneath this at the rate of a dram to 1 cubic foot or less of space

inclosed. A tablespoonful serves for ordinary tubs. This treatment does not injure the plant, and if the tub fits tightly to the ground the vapor of the bisulphid is retained and the lice will all be killed. This remedy is much used by growers of melons and cucumbers who watch their vines carefully, removing and destroying affected plants and fumigating those which can be saved.

THE BEET APHIS.

(*Pemphigus betæ* Doane.)

This insect is a root-louse and comparatively new as a pest. Attention was first drawn to it in 1896, and for three or four years afterwards it did considerable injury to sugar beet in Washington.[a] We do not know its full life history nor its distribution, but it occurs also in Oregon and probably in California. In Oregon a thousand tons or more of beets were ruined in a year in a single valley. This insect is one of many which may be seemingly harmless up to a certain point, but, with a changed environment, become of more importance economically.

The smaller rootlets of beets are first attacked and, when the aphis occurs in large numbers, they are soon destroyed. The loss of these so weakens the plant that it is not able to withstand further attack, and, as a result, the leaves wither and the beet shrivels and becomes spongy. Wild yarrow (*Achillea lanulosa*) appears to be a normal host plant, and when its roots are examined in localities where the insect abounds, they will frequently be found covered with the white woolly excretion of the insect, while the louse itself is feeding on the smaller rootlets. This species also lives on knotweed or door-mat weed (*Polygonum aviculare*), on grasses, and some other plants. It is likely to increase its range, but this may be a matter of slow accomplishment, unless it is introduced from one locality to another on beets in shipment.

METHODS OF CONTROL.

Owing to the large acreage which is planted in sugar beet in many portions of our country, it does not seem probable that we can treat satisfactorily an insect like this root-louse, which feeds underground, by means of insecticides. Kerosene emulsion and bisulphid of carbon will no doubt kill it, but the expense would be excessive were either used on a large scale. Nor can we hope entirely to eradicate the pest when it has taken up quarters in our fields by means of cultural methods. Additional observations on its life history and experiments look-

[a] Cordes: Sugar Beet Gazette for November, 1899; Doane: Bul. 42, Wash. State Agr. Expt. Sta., 1900, pp. 3–11.

ing to better methods for its destruction are necessary. It has been reported of the beet-root louse, which will receive next treatment, that in spite of heavy flooding and plowing in winter, the exposure of infested soil to frost, the number of the insects the following year was much larger. Nevertheless, in some localities these farming methods might be employed with better success against one or the other of these two insects. The best that can be recommended at the present time is to avoid planting beets on land where other food plants of this root-louse grow and where it is known to be established, and to practice judicious rotation of crops. It is advisable also to search for these food plants and destroy such as are of no value. Where the insects are found here and there in fields it might be found profitable to kill them by means of kerosene emulsion applied to the roots so as to soak down into the ground, making use of this remedy before rainfall or following it where possible with a copious flooding of water.

Possibly in time some of our insect friends, such as certain forms of ladybirds, syrphus flies, or parasitic insects, may come to the rescue and solve the problem. Ants are without doubt associated with this as with other root-lice and serve as distributors of infestation by carrying wingless lice from plant to plant. If ants occur in the same fields and it can be seen that they foster the root-lice, their nests should be sought out and destroyed.

THE BEET ROOT-LOUSE.

(*Tychea brevicornis* Hart.)

The above name is suggested for a subterranean plant-louse described in 1894 (18th Rept. Ins. Ill. for 1891–92, p. 97), and found about corn roots in Illinois. Considerable complaint has been made of injury to sugar beets in Colorado in 1901 and 1902 by what is now considered this species. It was described as sapping great numbers of beet roots, diminishing the stand to a large extent. The winged insect was noticed as early as April 1st. A correspondent of the division of entomology, Mr. W. K. Winterhalter, stated that many fields in the Arkansas Valley were infested, and expressed the opinion that if the pest should continue to spread, the sugar-beet industry might be seriously damaged. It is quite apparent that this insect is increasing as a pest, and that it will be difficult to control, as it has already shown its capability of development on a variety of plants, including wild grasses and cereals, among which are corn and sorghum, and such weeds as pigweed, lambs-quarters, "salt-grass," and purslane.

Remedies.—The remedies to employ are the same as for the preceding species of root-louse.

WHITE GRUBS AND MAY BEETLES.

Several species of white grubs and wireworms, the young of May or June beetles and of "snap bugs" or "skipjacks," respectively, attack the roots of beets, but none of them appear especially to favor this form of food and we have yet to learn of very serious damage by any of them. Both of these forms of insects follow the planting of beets in grass lands, and if some other plant be used as a first crop before the planting of beets in virgin prairie or in sod land the chances of infestation will be reduced to a minimum.

It is recorded that about 15 per cent of a field of beets was once destroyed in Nebraska by white grubs, and the roots of beets in central Illinois have also been injured, causing the plants to wilt. Only two forms of white grubs have been identified with attack on beets, but there are undoubtedly many more which affect this crop.

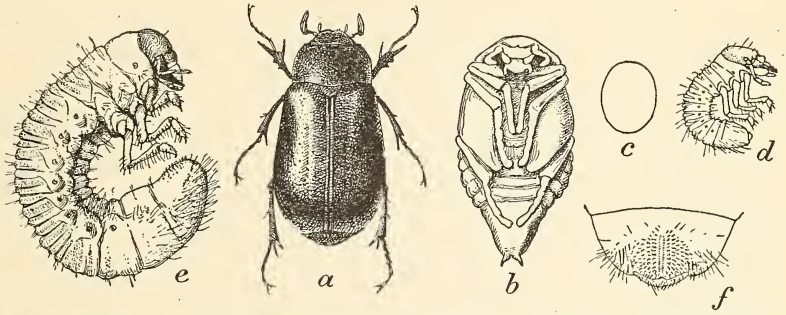

FIG. 59.—*Lachnosterna arcuata: a*, beetle; *b*, pupa; *c*, egg; *d*, newly hatched larva; *e*, mature larva; *f*, anal segment of same from below—*a*, *b*, *e*, enlarged one-fourth; *c*, *d*, *f*, more enlarged (author's illustration, Division of Entomology).

One of the commonest forms of May beetles is illustrated, with its white grub, in figure 59, which also shows the egg and pupa. A more complete account of this species is furnished in Bulletin 19, new series, of the Division of Entomology (pp. 74–80).

THE RUGOSE MAY BEETLE.

(*Lachnosterna rugosa* Mels.)

This species was found by Forbes and Hart in the year 1900 injuring the roots of beets in central Illinois and causing the plants to wilt. The beetle is of about the same size and color as the arcuate May beetle previously mentioned. It is a little paler, however, and the elytra are more distinctly lined with ridges, while the thorax is more strongly and much more closely covered with punctures. Its distribution extends from Massachusetts to Louisiana and Texas, and westward to Colorado and Montana.

METHODS OF CONTROL.

Living as white grubs do, underground, and often at a very considerable depth below the surface, it is obvious that it is a matter of extreme difficulty to reach them with insecticides. Gas lime has been suggested for this purpose, and good results have followed the experimental use of bisulphid of carbon and kerosene emulsion against allied species.

Kerosene emulsion is an effective remedy where small areas, such as beds of strawberries grown for home consumption, are affected. It should be diluted about ten times, and poured over the surface of the ground about the infested plants. It is well to make the application just before rainfall, that it may be washed deep into the soil, so as to come into direct contact with the larvæ. If rain does not fall within a day or two after its application a copious watering should follow.

It is to be regretted that both the bisulphid of carbon and kerosene emulsion remedies are too expensive for use on a large scale, but white grubs may be effectually killed off on lawns and in small fields and gardens by the use of the latter.

Fall plowing.—Everything considered, the most useful remedy is found in fall plowing. The land should be thoroughly broken, so as to leave it loose, and the grubs and their parents, the May and June beetles as well, exposed as much as possible to the elements during the winter. This is particularly valuable in cold weather, as the white grubs are not able to withstand exposure to a severe frost. A cross plowing is sometimes advisable where there is severe infestation. This will insure the ground being often disturbed, and if it is kept clean of weeds and other vegetation the grubs will be held in nearly complete control though not exterminated. Summer fallowing of infested land is said to be useful.

Rotation of crops is also valuable in connection with fall plowing. In case infested meadow land is desired for the planting of beets, corn, strawberries, or other crop subject to severe injuries by white grubs, an application of fertilizer, such as nitrate of soda or kainit, put on as a heavy top dressing after the ground is prepared and before planting, has proved of benefit in some cases.

Domestic animals.—Chickens and turkeys, as well as several species of insectivorous birds, are efficient destroyers of white grubs, and much good may be accomplished by encouraging domestic fowls to follow in the furrows to pick up the grubs as they are turned up by the plow. Hogs, as is well known, are also exceedingly fond of white grubs, and if allowed the run of localities where these are abundant, after the crop is made, they will root up the ground and devour great numbers of them. These and many wild animals also kill and devour the beetles when they have opportunity.

Care in the selection of manure.—As manures are frequently infested by white grubs, some of which are at times troublesome, it is well to exclude such forms as experience has shown to contain an excess of these creatures, as, for example, horse manure. The white grubs can be identified readily by disintegrating the material, and chickens and other fowls can be utilized in destroying them before the manure is spread on the fields.

Attracting to lights.—May beetles are strongly attracted to lights, and especially to electric-light globes. They can be captured to some extent by means of stationary lanterns and pans of water, on which is floating a thin scum of kerosene, placed below the lanterns. The traps should be stationed at intervals about an infested field, particularly around its borders.[a]

THE CARROT BEETLE.

(*Ligyrus gibbosus* DeG.)

This beetle was reported during the year 1890 by Professor Bruner as having been quite destructive to the sugar beet in the western portion of Nebraska. They worked for the most part on old ground where irrigation was practiced, and their operations extended on the roots from the surface of the ground to 3 or 4 inches below; in some instances 7 inches.[b] This insect is better known as a carrot pest, and is, in fact, one of the worst known enemies of carrot, parsnip, and some related plants. Injury is due to both larvæ and beetles. Young corn is often cut just above the roots, and the root crops mentioned are punctured with little holes, rendering them unfit for market. Tubers of potato and sweet potato are also subject to attack, as are the roots of celery. Other plants affected include the roots and tubers of sunflower and dahlias as well as cotton.

FIG. 60.—*Ligyrus gibbosus:* adult—enlarged (original, Division of Entomology).

The beetle closely resembles the May beetle, but it will be noticed by reference to figure 60 that the surface of the wing-covers is strongly sculptured and coarsely punctate. The beetle measures about a half to five-eighths of an inch in length, with considerably shorter legs than in the true May beetles. The dorsal surface is similarly colored,

[a] NOTE.—It is often desirable to protect choice trees against the ravages of the beetles. For this purpose nothing is better than mosquito netting. Beetles may be beaten from the trees into inverted umbrellas or similar receptacles, and can be readily captured and killed, as they make little effort to escape after being dislodged. Spraying with arsenicals is of no practical use, as the beetles continue feeding until the poison takes effect, and the next day the dead are replaced by other individuals.

[b] For particulars see Bul. 23, o. s., Div. Ent., p. 17.

but the lower surface is reddish brown and the legs are clothed with reddish-yellow hairs.[a]

Remedies.—Unfortunately the carrot beetle works under ground, like common white grubs, and for that reason is as difficult to control. Injury is largely confined to the beetles, although the larvæ do some injury. If we could ascertain the principal breeding places, this might furnish a solution of the problem. The grubs may be treated as described in preceding paragraphs. In a case of reported injury to the roots of sweet corn in Minnesota in 1902 the presence of the carrot beetles was traced to their having developed in horse manure on the infested grounds;[b] hence avoiding the use of this as a fertilizer or the destruction of the white grubs in the manure is recommended. Crop rotation is one of the best remedies, and it is probable that trap lights might yield good results, as these insects are more attracted to bright lights than are ordinary May beetles, although it is not known to what extent the beetles might be lured from the fields after they have begun to feed.

WIREWORMS.

The sugar beet, as has been said, is so nearly exempt from injury by wireworms that this plant, as also spinach, might be profitably used as an alternate in the cultivation of corn, various other cereals, and vegetable crops, such as potatoes, which are frequently very badly infested by these insects. Occasionally wireworms of several species have been found eating into the smaller roots of beets and burrowing into the tap roots and crowns, causing the plants attacked to shrivel and die. Messrs. Forbes and Hart have indicated two species of wireworms as having been concerned in such injury, *Melanotus cribulosus* and *Drasterius elegans*, both of which have been observed about beet roots which had been more or less injured and eaten away.

The term wireworm is applied to numerous forms of elongate wire-like creatures, the larvæ of snapping beetles or "snap-bugs," of the family Elateridæ. Many species are injurious to cultivated crops and are often very troublesome in cornfields. A large proportion of the wireworms are shining yellow in color, while many of the adults, like the species figured, are brown and covered with close brown or yellowish pubescence.

The life history of injurious subterranean species is in some respects similar to that of white grubs, the beetles being among the earliest spring arrivals, occurring in April and May, and flying rapidly in the heat of the day.

The eggs are generally deposited in moist places grown up with grassy vegetation, weeds, or corn, and the larvæ upon hatching feed,

[a] A more complete account is given on pp. 32–37 of Bul. 33, n. s., Div. Ent.

[b] Washburn, 7th Rept. Ent. Minn. for 1902, pp. 47–49.

like the white grubs, upon the roots, developing slowly and requiring about the same period for the perfection of the life cycle—about two or three years. Like the white grubs, also, the wireworms transform to pupæ in autumn, and the change to the beetle form takes place before winter, the beetles usually remaining in a quiescent state until their emergence the following spring.

Two common and injurious species are chosen as examples of this class, although it must be remembered that they have not been determined as beet feeders. The first is known as the wheat wireworm (*Agriotes mancus* Say), and is shown four times natural size in figure 61. The other is called *Monocrepidius vespertinus* and is introduced here because known in its three principal stages (fig 62).

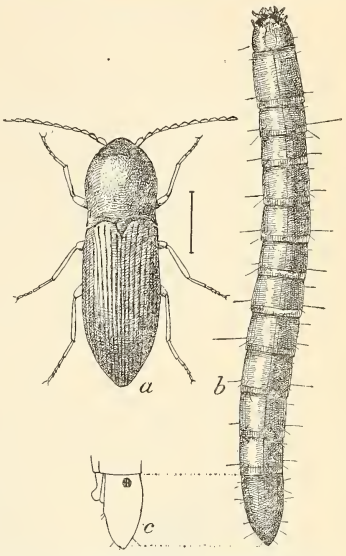

FIG. 61.—*Agriotes mancus: a*, beetle; *b*, larva; *c*, anal segment of larva in profile—about four times natural size (author's illustration, Division of Entomology).

Remedies.—Owing to their extremely hardy character, indicated by the hard, firm texture which has given them the name of wireworms, as well as to their subterranean nature, these insects are even more difficult to treat satisfactorily than the white grubs.

Of direct applications, poisons are of little value, but salt in large quantity has been used by some persons with success for many years, and has been reported to be one of the most effective applications that can be made. Strong brine, however, must be used with caution, as it sometimes destroys certain forms of plant life. Different forms of salty fertilizers are also said to be of value, both as stimulants to the affected plants and as insecticides. Among these are kainit and nitrate of soda.

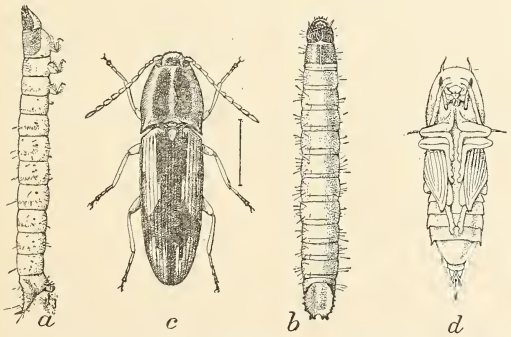

FIG. 62.—*Monocrepidius vespertinus: a*, larva, side view; *b*, same, dorsal view; *c*, beetle; *d*, pupa—about three and one-half times natural size (author's illustration, Division of Entomology).

Clean cultivation and poisoned baits are also recommended, the same as for white grubs. In fact, where remedial measures are in use against either cutworms or white grubs, they apply also to wireworms, but are less effective.

One of the best forms of bait to be used consists of slices of potatoes or other vegetables poisoned in the same manner as advised in the consideration of cutworms.

MISCELLANEOUS ROOT-INFESTING INSECTS.

In addition to white grubs, wireworms, and root-lice, which have been treated as invading the underground portion of beets, a few other species are found at the roots. Prominent among such are the seed-corn maggot and the clover-root mealy-bug. A number of complaints have been made of injury by insects which lead to the belief that the seed-corn maggot is frequently found on beets, although instances which could be positively traced to this species are comparatively few.

THE CLOVER-ROOT MEALY-BUG.

(*Dactylopius trifolii* Forbes.)[a]

This species, as its common name indicates, is better known as an enemy of clover, on the roots of which it feeds. In 1901, however, it appeared in considerable numbers on sugar beet in Michigan, the smaller stunted roots being invariably infested. Injury was most apparent in June. The female mealy-bug measures a little more than one-twelfth of an inch in length, is reddish brown, and covered with a waxy or mealy secretion. The legs are dirty yellow, and from the sides project in the manner usual to this group 15 to 17 waxy filaments, the shortest being near the head and the longest near the tail, sometimes one-third as long as the body. It is related to the scale insects and is of similar appearance to the species shown in figure 63.

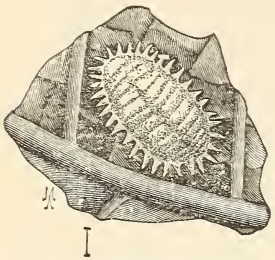

FIG. 63.—*Dactylopius citri:* female—enlarged (Division of Entomology).

Remedies.—The same methods of control that have been prescribed for root-lice would operate against the present species, with about the same results.

THE SEED-CORN MAGGOT.

(*Pegomya fusciceps* Zett.)[b]

Beet roots are subject to attack by the above-named species of root maggot. During November of 1902 we received complaint of what was with little doubt this insect from Colorado, where it was breeding in rot-infected roots, apprehension being expressed that

[a] Syn: *Coccus trifolii* Forbes; 14th Report State Ent. Ill. for 1884 (1885), pp. 72–73; Pettit: Bul. 200, Mich. Agr. Exp. Sta. for 1901 (1902), pp. 193–194; Davis: Insect Life, Vol. VII, p. 172.

[b] See Bul. 33, n. s., Div. Ent., pp. 84–92, for synonymy, bibliography, etc.

although injury was not then noticeable the insects might do damage the following spring. Such a sequel is often to be expected, and it seems probable that many reported instances of injury by this and related forms of maggots are due to their habit of developing on decaying vegetable and other matter and afterwards attacking roots and taproots and other healthy vegetation of the vicinity. Most vegetables, more particularly beans, peas, and maize, are subject to damage, and cabbage, turnip, radish, onions, and sweet potatoes are also much affected. The insect which is generally distributed in the United States is shown in its different stages in figure 65. It resembles the beet or spinach leaf-miner previously considered. The particularly distinguishing characteristic of the fly consists of a row of short bristly hairs of nearly equal length on the inside of the posterior tibiæ of the male (fig. 64, *a*). The length of the wing is about one-fifth and of

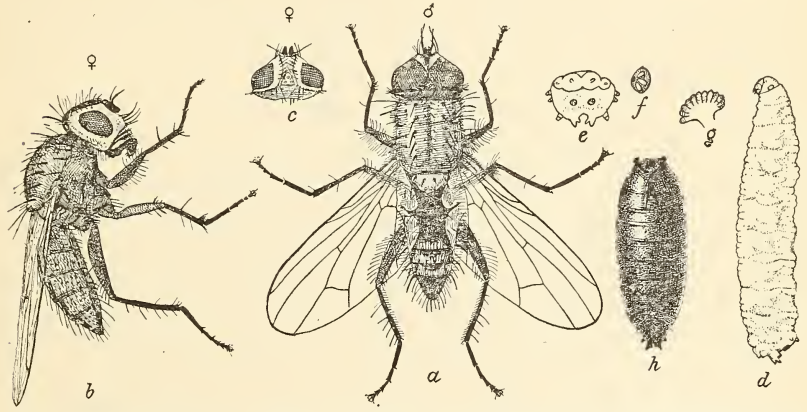

FIG. 64.—*Pegomya fusciceps: a*, male fly, dorsal view; *b*, female, lateral view; *c*, head of female, from above; *d*, larva, from side; *e*, anal segment of larva; *f*, anal spiracles; *g*, thoracic spiracles; *h*, puparium—all much enlarged (author's illustration, Division of Entomology).

the body about one-sixth of an inch. The maggot as well as fly resembles the onion maggot. There is little doubt that this insect is of European origin, and it is certainly increasing in destructiveness in this country.

Remedies.—Owing to the difficulty of destroying subterranean pests and the cost of chemicals for the purpose, such as bisulphid of carbon, we have to depend more upon methods of prevention. One way of deterring the parent flies from depositing their eggs consists in the use of sand soaked in kerosene—a cupful to a bucket of dry sand—which is placed at the base of the plants, along the rows. This also kills young maggots that may attempt to work through the mixture.

Fertilizers are also useful as deterrents, particularly when employed just before or after a shower has thoroughly wet the ground. They should be applied as nearly as possible to the roots, and the earth

should be turned away from the plants for this purpose. They possess the advantage of also acting as a stimulant to plant growth. Stable manure is apt to induce infestation, as this species is well known to develop in excrement and other decomposing material. As soon as plants show signs of wilting and maggots are known to be present, the injured plants should be promptly pulled and destroyed.

The above methods have been used with success against onion maggots and similar root-feeding species, and may be all that is required in the case of ordinary infestation of beets.

One of the best remedies for root maggots is bisulphid of carbon. It has been used with more or less success by Prof. A. J. Cook and others since 1880. In its application great care should be exercised that the liquid shall not come in direct contact with the roots of the affected plants. Directions for the treatment of plants affected by root maggots are furnished on page 14 of Farmers' Bulletin 145, a copy of which can be had upon application to the Secretary of Agriculture.

THE RED SPIDER.

The common or two-spotted red spider (*Tetranychus bimaculatus* Harv.) is usually present in most fields of sugar beet east of the Rocky Mountain range, but it is preeminently a greenhouse pest, and as a rule does comparatively little injury to plants growing out of doors. It is unique as a vegetable pest in that it is not a true insect, nor even a spider, as the popular term would imply, but a spinning mite. As the word mite indicates, these creatures are extremely minute, and are frequently not noticed until they become excessively numerous, as is apt to happen during summer droughts. They do considerable damage in flower and vegetable gardens, but attain their greatest destructiveness in connection with plants grown under glass.

The general appearance of the common red spider is shown in figure 65, highly magnified. The length of a full-grown individual is only about one-fiftieth of an inch. The ground color is reddish, usually more or less tinged with yellowish or orange, and most individuals have a dark spot on each side, due to the food contents of the body. The young are similar to the adults, differing in having only three pairs of legs, while the adults have four. This red spider spins threads, but does not use them for climbing. The threads are frequently so numerous as to form a tissue visible at a little distance. Webs are usually constructed on the under sides of leaves and within them the mites feed and lay their eggs from which the young develop.

This red spider is quite likely of foreign origin, but its distribution has not been carefully studied.

It is inclined to be omnivorous, attacking a wide range of plants. As the red spiders increase in number the leaves of an affected plant

turn pale and become stunted, and eventually the whole plant succumbs unless remedies are applied. Cuttings and young rooted plants are especially susceptible to injury, and more particularly in spring. These mites injure by suction, slowly reducing the vitality of plants until in time their functions are more or less deranged. Among ornamental plants that are much affected are violet, rose, clematis, minuet, pink, fuchsia, pelargonium, godetia, passiflora, feverfew, thunbergia, verbena, heliotrope, moonflower, calla, smilax, and Easter lily; while of other crops, beets, beans, sage, tomato, eggplant, pepper, cucumber, squash, cowpea, hops, and berries of various kinds are attacked. As a rule this species is not especially harmful to the sugar beet but is quite destructive at times in fields of other crops; for example, to beans, which have been badly injured in South Carolina in recent years.

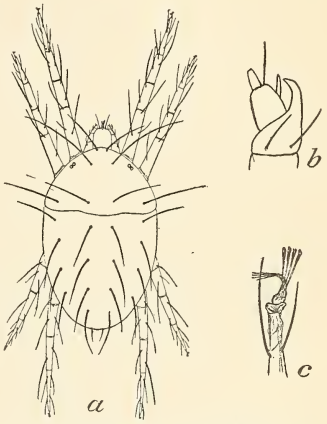

FIG. 65.—*Tetranychus bimaculatus: a*, adult; *b*, palpus; *c*, claws (after Banks, Division of Entomology).

Remedies.—This red spider is resistant to "gassing" or fumigation, either with tobacco or hydrocyanic-acid gas. It is, however, peculiarly susceptible to sulphur, a sovereign remedy for mites in general. Flowers of sulphur mixed with water at the rate of 1 ounce to the gallon and sprayed over the plants is of great value in its eradication; or the sulphur may be combined with a wash, for example, with strong soapsuds.

Potash, fish oil, whale oil, and other soap solutions, resin wash, and kerosene-soap emulsion are also valuable, and the addition of sulphur increases their effectiveness; but these washes are too strong for some delicate plants and are apt to injure them. For violets and similar plants, as they occur in greenhouses, no other remedy is used by florists generally than frequent syringing or spraying with water or with a solution of neutral soap. Directions for the application of the soap washes to violet and other greenhouse plants are furnished in Bulletin 27, new series, of the Division of Entomology (pp. 40–42).

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U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF ENTOMOLOGY—BULLETIN No. 43.

L. O. HOWARD, Entomologist.

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A BRIEF ACCOUNT

OF THE

PRINCIPAL INSECT ENEMIES OF THE SUGAR BEET.

BY

F. H. CHITTENDEN,

Entomologist in Charge of Breeding Experiments.

WASHINGTON:

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